October 2010

Mystery of Superbug Pg 44

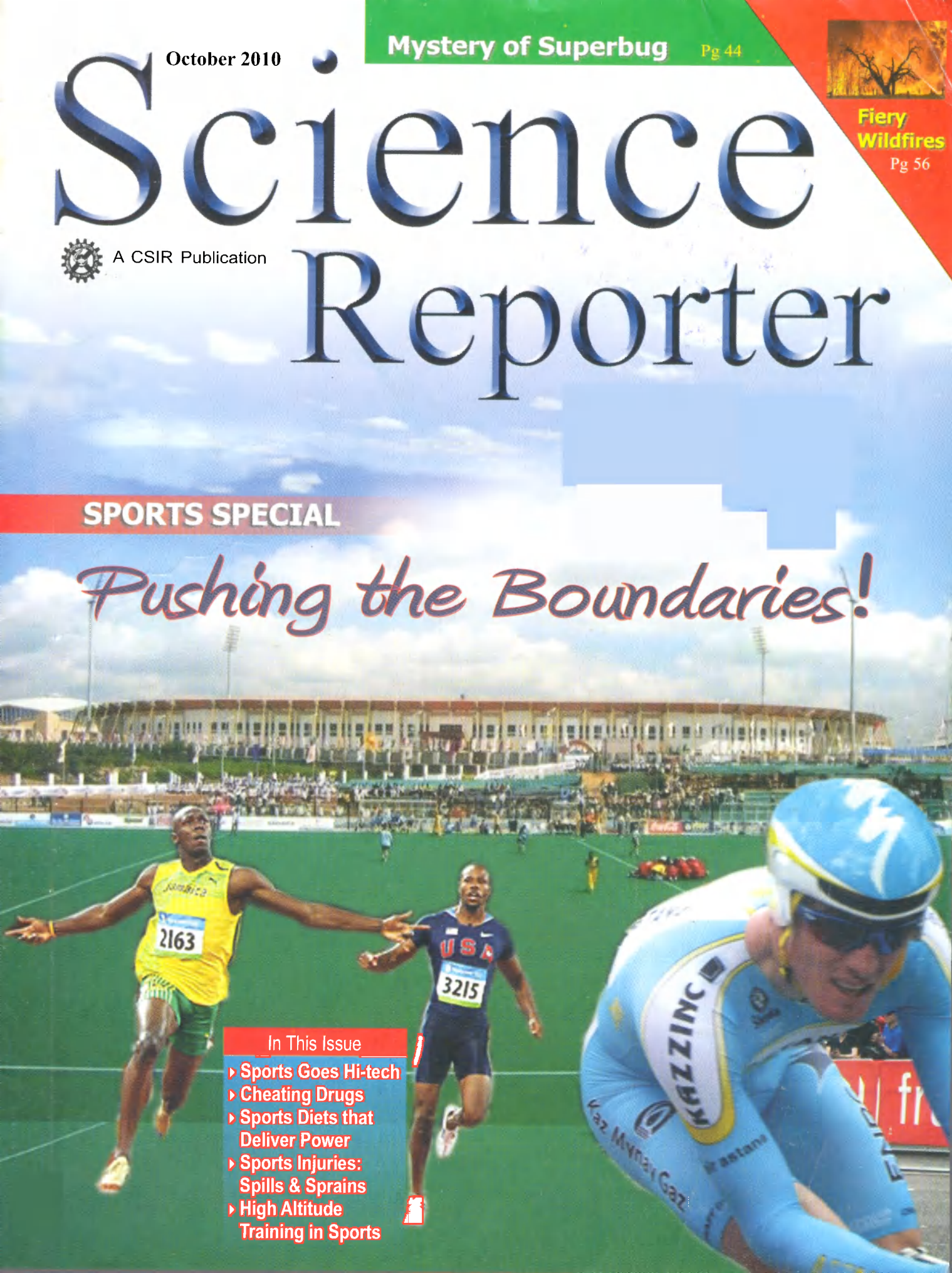
Fiery Wildfires Pg 56

Science Reporter

A CSIR Publication

SPORTS SPECIAL

Pushing the Boundaries!



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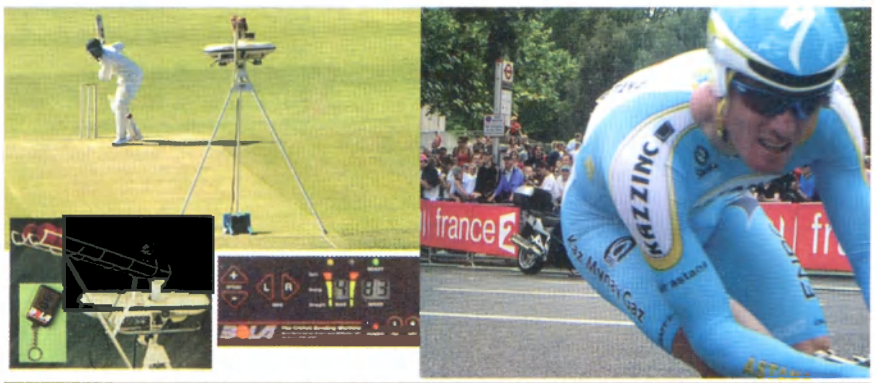

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Red Alert about Water Scarcity

The article There Goes the Elixir of Life...Water by Dr. K.P. Agrawal (August 2010) brings out the true picture of the water crisis we are facing today. Although alarm bells relating to the scarcity of this precious liquid have been ringing since the past two or three decades,

by nature perhaps human beings are not programmed to heed to warnings until the last stage is reached when there is little scope of retracing the steps.

There is a long list of perils like population explosion, food shortage, land crisis, pollution, global warming etc that can be cited as being of concern and which are only worsening by the day, but the most critical obviously is water scarcity. But still all is not lost. By following some simple measures as mentioned in the article and turning them into regular habits we can save a huge quantity of water.

Swapan Rudra
Sonamukhi Bankura (W.B.)

Hostility at Sea

Sabahuddin Ahmed has tried to convey the horrors of land mines in his article Curse of Land Mines (August 2010). Their 'sea-cousins', the naval mines, are no less dangerous. It may perhaps be mentioned that as Head of Naval Operations and Analysis Division (NOAD) my group was entrusted the task of finding the safe route for a ship leaving harbour under hostile environment. Needless to say that one of the hostile factors we had to take into account was the presence of minefields. The solution of the problem required Monte Carlo simulation. Prudence dictates that further elucidation would be improper.

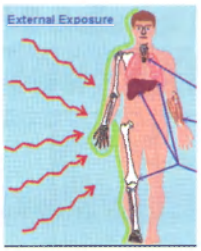
Whether on the surface or sub-surface, the sea-mines

patiently target unsuspecting ships and submarines. They make use of acoustic, pressure and magnetic sensors and over the years have attained a high degree of sophistication, accuracy and lethality. A single mine is capable of thwarting ship operation until the area is 'sanitized'. Mine warfare is done in a clandestine manner and is solely aimed at denying the enemy access to the sea. The naval mines can be laid by an aircraft, minelayer or submarine. Sweeping the minefield can be done by minesweeper, aircraft or submarine. It is an arduous and time-consuming process. Actually, it is much cheaper and quicker to produce and deploy a mine than to clear it.

Dr. S.K. Gurtu
Mansarovar, Jaipur

Piercing Radiations

The article, Polluting Rays Strike Out, published in the June 2010 issue was very useful and indeed timely. The exhaustive details about the radiation effects caused by electrical and electronic appliances used in day-to-day life should be given wide publicity so as to reach the educated population. The radiation caused by mobile phones and its effects on



growing children should be prioritized as the use of mobile phones has increased tremendously in recent years. The author and *Science Reporter* deserve appreciation for their efforts towards this social cause and I wish them to continue their work.

V. Chandrasekaran
Karaikal, Puducherry

Save Plastics in Schools

I read a most informative and an action-oriented article in the June 2010 issue—Plastics Boon or Bane? In this regard I want to put forward certain observations related to the use of non-biodegradable and the silent killer "Plastics". In schools, these days the word "project" has become very popular in all the subjects and for all the classes. Whatever text is written on unruled or

even ruled sheets has to be kept in a 'plastic-cover' and it becomes a project. The true meaning of a project is far away from this futile exercise. In subjects like languages and mathematics, or even science subjects, the content that can be easily written and preserved in notebooks is asked to be written on sheets. Sometimes the students take out computer printouts. These sheets or printouts are then safely enclosed within a plastic cover (named as a project file).

I feel that information can also be written and preserved in a small notebook for years together in place of "plastic project file". Since project-work is a part of the curriculum in chemistry (class XI & XII), we must encourage our students and teachers to prepare the project file without plastic covers and marks can be allotted if data and observations in the project are true and comprehensive.

By discarding plastic covers for files and encouraging students to make projects in notebooks we will save huge quantities of plastics.

Jagdish Chandra Patidar
PGT Chemistry, Jawahar Navodaya Vidyalaya, Raichur, Karnataka

Excellent Guide

The August 2010 issue of *Science Reporter* was excellent. I am a regular reader of *Science Reporter*. It gives me good scientific knowledge. If we receive good guidance in life we can indeed be successful. I think *Science Reporter* is a very important guiding tool that also gives us a lot of self-confidence, courage and strong will power, all of which are necessary to achieve success.

Sanjay Goswami
BARC, Mumbai

HAVE YOUR SAY

If you feel strongly about any article or write-up published in *Science Reporter* or have some information to share with the readers, please write to us at the postal address given in the magazine or send an Email at sr@niscair.res.in.

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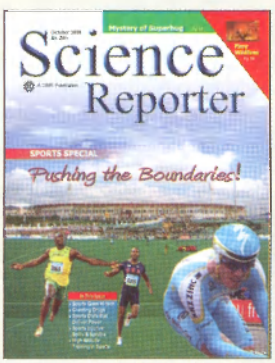


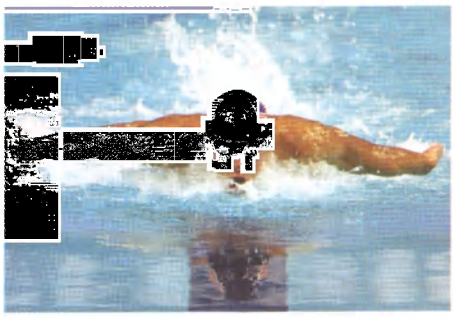
COVER DESIGN
NEERU SHARMA

The Science in Sports

The Commonwealth Games 2010 are all set to roll out in New Delhi in the first week of October. Sportspersons from around the world are getting ready to pit their might against each other, to test their techniques, and to assess whether all their hard work has been worth it.

Sports are a delightful mix of a high level of physical performance, mental agility and turbulent emotions. Aches and pains, spills and sprains, the agony of defeat and the ecstasy of victory—all these are an intimate part of sporting events. But what has come to define today's sports more than ever is the ingress of science and technology to give sportspersons that winning edge.

What sort of exercise regimen to follow? What to eat for those extra reserves of energy to stay a step ahead of others? Which technique would bring out the best possible performance? What footwear to wear? Science provides most answers. So much so that sport science has become a discipline in itself today.



Behind today's record-breaking sportspersons are faceless men and women whose duty it is to nurture precocious talent so that they bloom into superstars. This unsung band of nurturers comprises coaches, orthopaedists, anthropometricians, paediatricians, and a host of other practitioners of arcane disciplines. In fact, the single most important force responsible for the performance explosion of this century is the application of science and technology to sports.

The synthetic tracks and temperature-controlled swimming pools, the fibre-glass poles and newer javelins and discuses, funny bikes that cheat the wind and springing shoes that seem to make runners fly, breathing fabrics that are also adept at soaking sweat, hi-tech exercise equipment that help sportspersons add power to specific muscles—all these are products of science.

Sports techniques too draw heavily upon scientific principles. The cycling technique once the long jumper is in the air was introduced to add a few extra feet to the jump. The reverse swing in cricket, the topspin in lawn tennis, the loop shot in table tennis and the sidespin in snooker—all these seemingly incredible feats involve no more than a subtle manipulation of aerodynamic principles. Expert footballers are playing with the air as they hand out a swerving kick.

But then, just as a coin has two sides, science has also been employed for sinister purposes in sports. The use of drugs to enhance performance is a worldwide phenomenon today. Fortunately, in several instances such malpractices have been brought to light thanks to sleuths leading the fight against misuse of drugs in sports.

The interface between science and sports continues to grow. And it is only to be expected that improved training methods and technological innovations will play an important role in elevating sports performances in the future too, raising the bar ever so often.

It is a momentous occasion indeed for India to be hosting the nineteenth Commonwealth Games. We hope the marathon preparations, the innumerable hurdles and the race to the finish have all been worth it. And we do hope to see a sporting extravaganza that the country can be truly proud of.

Hasan Jawaid Khan

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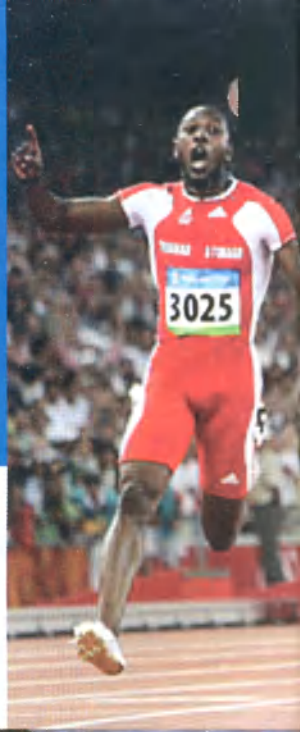
HI-TECH SPORTS

TECHNOLOGICAL REVOLUTION IN SPORTS



In an age where fractions of seconds decide winners in sporting events, science and technology is truly working overtime to equip sportspersons with that winning edge that could fetch them glory.

N.S. ARUN KUMAR

ZOLA Budd was born in South Africa. A quarter of a century ago, she was a teenage runner breaking the women's 5000 m record by 10 seconds. But how does that make her special? Well, she ran bare foot!

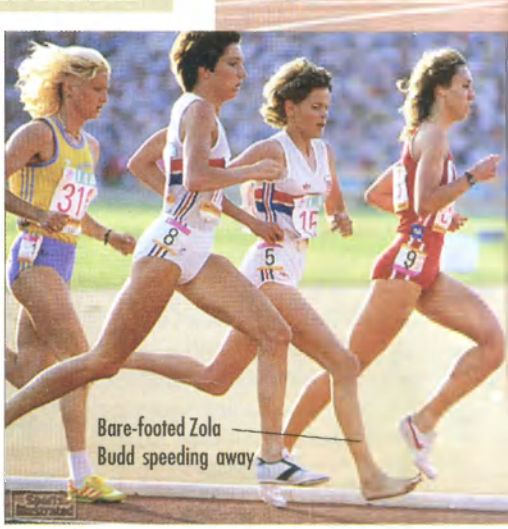
At the prime of her fame, she was brought to Britain and sent to compete in the 1986 Los Angeles Olympics through a hasty subjugation of citizenship. Her immediate rival was the American blonde, Mary Decker, challenging her at the women's 3000 m. They came head-to-head and when there were three more laps to go, Decker staggered from her line and collided with Budd. She fell from the track and was unable to continue but the real damage was inflicted on Budd who was wounded by a spike from Decker's shoe.

Tears streamed from Budd's face as she struggled to continue with the gripping pain in her tendons, fading badly at the end and finishing seventh. It was a disappointing performance, and the boos and catcalls from the American crowd told as much. Perhaps the outcome would have been different had Zola Budd been wearing running shoes.

There is also the case of the Kenyan athlete Tegla Loroupe who was unable to afford her first pair of shoes until winning a cross-country race in 1986.

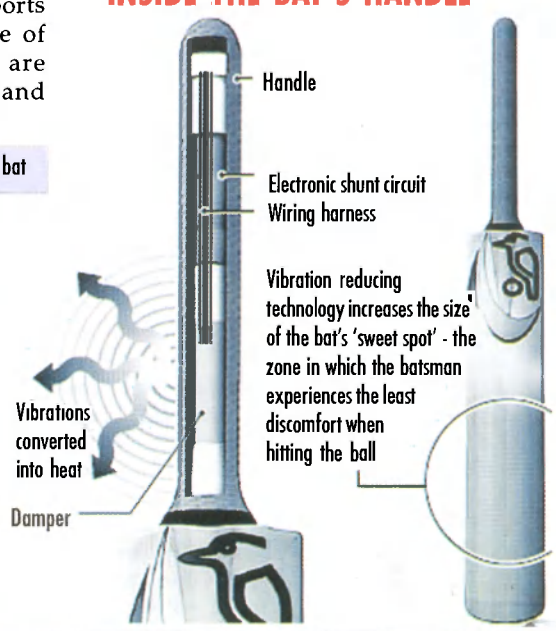
Today, however, a plethora of running shoes are available to fit the requirements of different sports. Lace-up croquet shoes with rubber soles and canvas uppers went on sale in the 1860s, thanks to the discovery of vulcanisation, the process of curing rubber by the addition of sulphur. This made way for the performance enhancing studded football boots, spiked running shoes and heel-less cycling shoes.

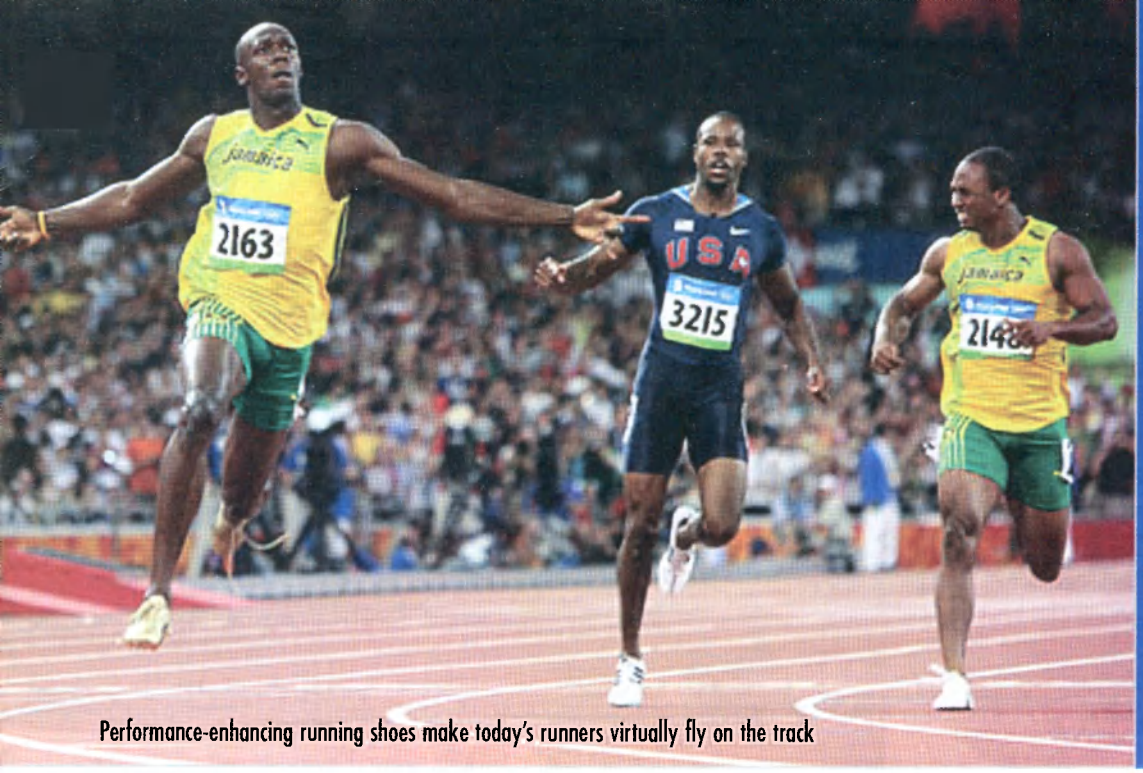
But modern sports has progressed much beyond sporting footwear. In fact, the modern sporting gear has truly become varied and hi-tech. For instance, you have protective wear, principally applying to sports where there is a serious chance of physical injury. Cricketers are pampered with leg-guards and donning gloves.



Technology works wonders for the modern cricket bat

INSIDE THE BAT'S HANDLE


Handle
Electronic shunt circuit
Wiring harness
Vibration reducing technology increases the size of the bat's 'sweet spot' - the zone in which the batsman experiences the least discomfort when hitting the ball
Vibrations converted into heat
Damper



Performance-enhancing running shoes make today's runners virtually fly on the track

Scientists, engineers, technicians, trainers and coaches are striving to give their athletes a slight edge, that could make the difference between winning a medal and going back empty handed.

Technology has also improved almost everything in sports, from training to recovery and diet to clothing. There can hardly be a muscle group that is not targeted by a sports machine that is designed to enhance bone density and ligament tensions. There are even machines that can replicate human opposition—"bowling apparatus" for cricketers and ball-launching assemblies for baseball and tennis players. Biomechanics has turned out to be a specialist area with the advent of 'motion analysis' tools assisted by sophisticated computer programs.

Science and technology have truly revolutionized sports today. There is no game that is untouched by this revolution. In competitions where the difference between winning Olympic medals and going home empty-handed is often measured in hundredths of seconds or fractions of centimeters, manufacturers of performance equipment seek to confer every allowable advantage on athletes. They do so through design innovations and by using materials that provide just the right combination of properties.

Some applications call for lightweight materials that provide structural support, vibration dampening, and stiffness. Other applications require materials that are flexible, breathable, and insulating, and that protect against impact, tearing, moisture, and wind.

Cricket bowling machine—practicing without the bowler

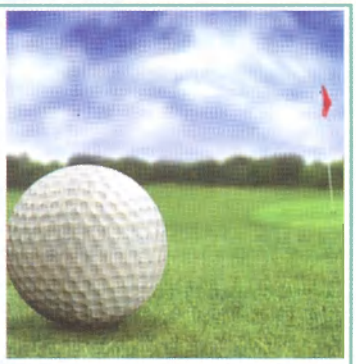
Science in the Game

During the first test of the Australia and England Ashes series in 1979-1980, Australia's fast bowler Dennis Lillee came to the wicket carrying a "brand-new" shining bat. When he drove the ball from England paceman Ian Botham, everybody heard an odd sound—a big clang! It was a blow sure enough to warrant a four but Lillee could run only three runs.

Australia's captain Greg Chappell, sitting in the pavilion blamed the bat for the shortfall, and sent a new bat to Lillee as replacement. England captain Mike Brearley complained to the umpires that Lillee's pinging bat was damaging the ball. Lillee, however, refused to obey even his captain's instructions and the game had to stop for a good 10 minutes. The bat was

Top range tennis players favour a composite frame

While regular soccer balls are made with 32 hexagonal panels, the Teamgeist for World Cup in Germany 2006 had only 14 panels. The Jabulani ball (above) used in the 2010 South Africa World Cup had an amazing 8 panels. It had a 'grip n groove' texturing that aids smooth flight and bonded 3D panels moulded spherically to retain shape and create a seamless sphere.



The featherie was the first golf ball used, it was tanned leather stuffed with goose feathers (extreme left); next came the guuta percha ball or the guttie ultimately followed by the modern dimpled golf ball

examined and it turned out that it was Lillee's own invention, forged out of aluminium! Lillee was ordered to complete his innings with a conventional wooden bat. Shortly after this, metal bats were outlawed through an amendment in the laws of cricket. This raised an interesting question: should games be played as per conventional laws or could science be allowed to step in?

If we look into the past history of the evolution of sports and sports-gear we see that this question has baffled many. From time immemorial, human beings have been manipulating the implements used in ball games. The Aztecs invented the rubber ball while the Australian aborigines had their own version called dumbung.

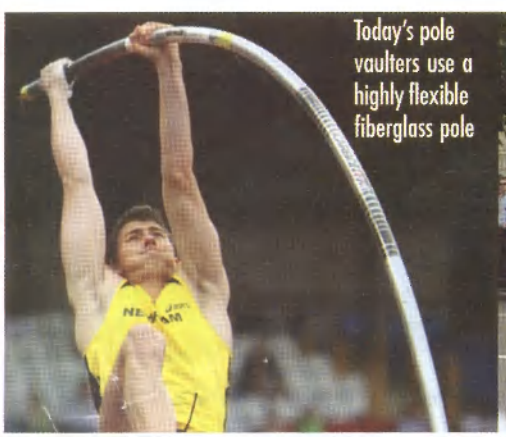
Until about thousand years ago, the basic equipments for all the ball games, the early precursors of golf, cricket, hockey and tennis, remained the same. Strangely, the earliest reference to a cricket bat is from 1624, when a fielder trying to catch the ball got hit with the bat and died because the bat was made of iron!

Similarly, by the late 19th century, tennis rackets were made from Ash wood carefully steamed and bent into a round shape. The racket strings were fashioned from sheep's gut, which was replaced by cow's gut after the Second World War, as they were found cheaper. There were not worldwide regulations governing the size and construction of tennis rackets up to 1979 and so many technological innovations were experimented with including different types of woods and other alternatives.

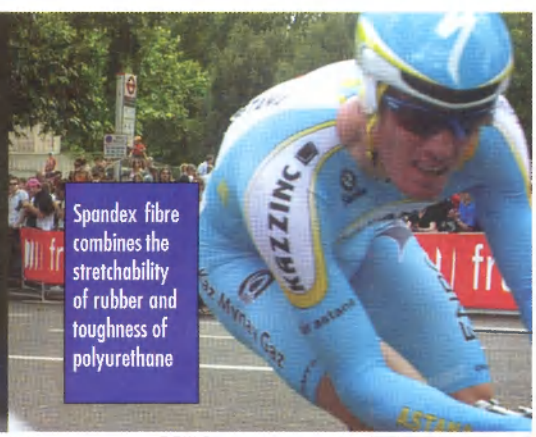
Technology's impact on the modern tennis game was mainly used to extend the power of shots. Metal rackets were in widespread use by the 1970s, which employed varieties of aluminium and steel. However, top-range players favoured a composite frame in which graphite was combined with a number of materials including ceramics, boron and Kevlar. The real advantage of the modern graphite racket was its greater stiffness, rather than lightness because it distorted little as it made contact with the ball.

The latest technology includes the incorporation of piezoelectric crystals into racket frames, which produce electricity under stress. The current generated by the ball hitting the strings is sent to the handle, amplified and returned to the ceramic composites in the frame. This causes the frame to stiffen and the result can be greater power and less vibration. But, there are some first class players who still prefer traditional wooden rackets.

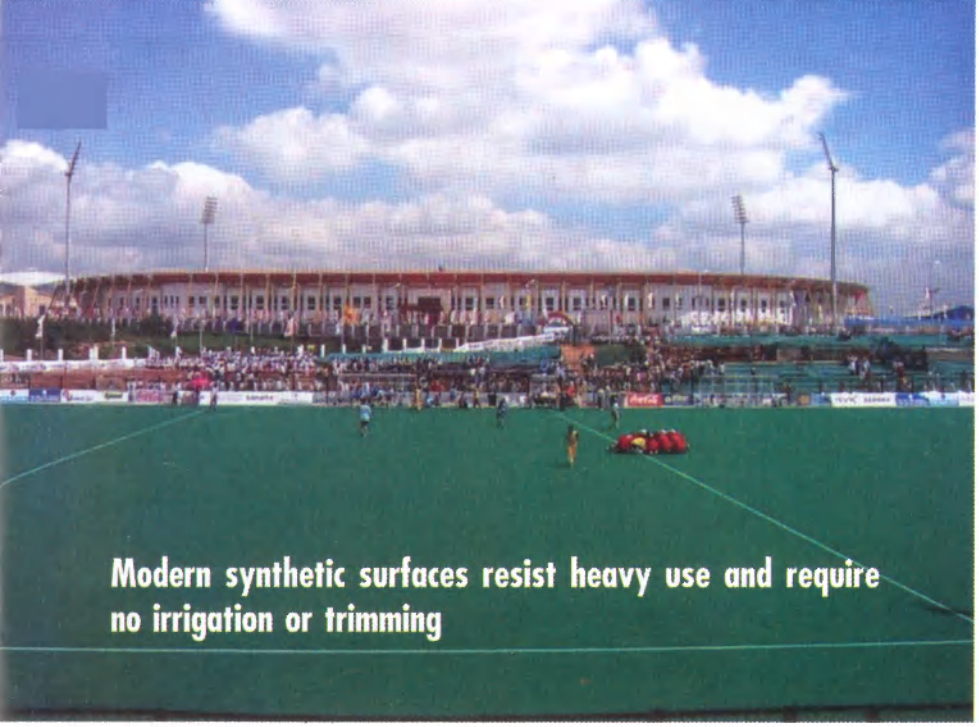
Cool sports wear made from Phase Change Materials



Today's pole vaulters use a highly flexible fiberglass pole



Spandex fibre combines the stretchability of rubber and toughness of polyurethane



Modern synthetic surfaces resist heavy use and require no irrigation or trimming

Today's cricket batsman is armoured with several protective guards

Golf has had a long enduring alliance with technology. At first there were handcrafted clubs carved out of heavy hardwood heads of Holly or Apple trees. These leather-bound shafts continued till the middle of the 18th century right when they were replaced with metal heads. Though American Hickory had an intervening presence during the early 19th century, metal heads remained more common. This fascination prevailed to the extent that steel shafts were legalised in 1920s.

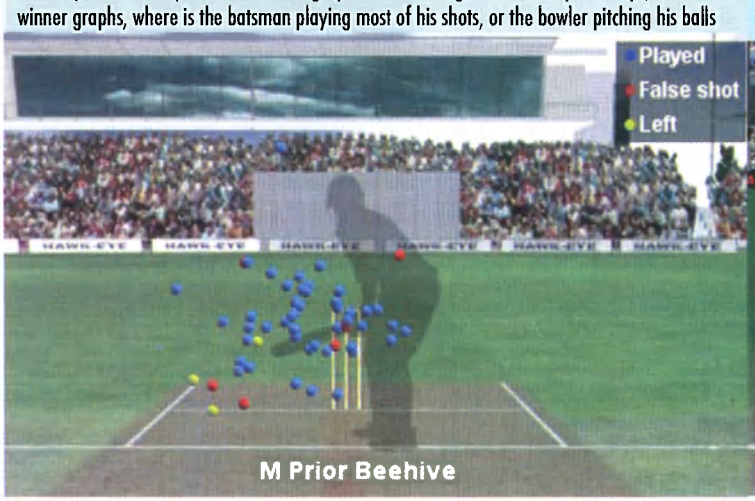
Unlike golf, however, the authorities controlling cricket, baseball and tennis resisted technological change resorting to hard-core conservatism in the case of table tennis. Cricket bats continued to look like hockey sticks until the emerging bowling techniques made it a parallel-sided willow bat. Fiercely opposing any technological innovations, the specifications of a cricket bat are now clearly laid down (Law 6) which stipulates the wooden blade to be covered with a material no more than 1.56 mm thick. Fortunately, the 'post-Lillee' laws leave two areas flexible: the handle of the bat and its weight. The cane and rubber handle of the traditional bat was replaced by carbon fibre with polymer insert. The material composition is made to give more weight lower down the blade making the batsmen carry an increased weight one third more than those used by the greatest hitters like Donald Bradman!

Ball of the Rings

In majority of the major games like football, cricket, golf and tennis, the physics of the ball plays a crucial part. Among the most thoroughly investigated, golf balls are most supreme and even the earliest balls were masterpieces of the technology of their days. The 'guttie' balls were a revolutionising attempt, which were made from the sap of the Malaysian Sapodilla tree.

Before this, there were the 'Featheries' made from three pieces of tough hide sewn together and then tightly stuffed with freshly boiled fowl feathers. After stitching up, the ball was hammered into shape while still wet, the expansion of the drying feathers making it very hard, later on.

Hawk-Eye offers unique and exclusive graphics - from wagon wheels to pitch maps, beehives to winner graphs, where is the batsman playing most of his shots, or the bowler pitching his balls



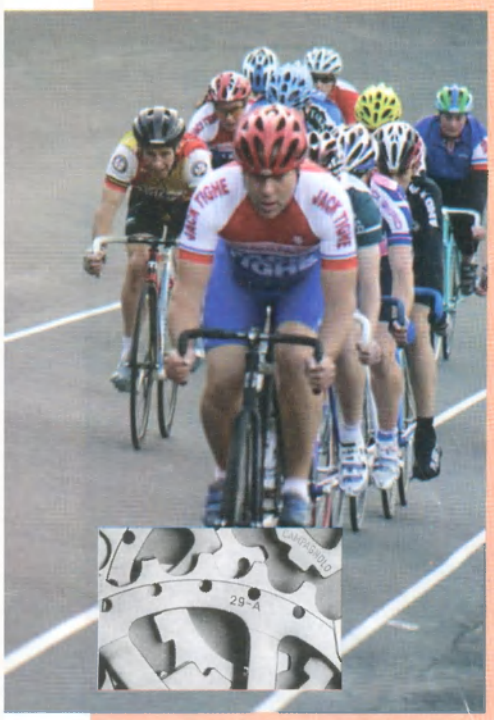
The snickometer can catch the faintest snicking sound

Super Racing Bicycles

A number of advances have contributed to the high efficiency of the modern-day bicycle, including the development of spoked wheels, the chain concept, pneumatic tires, and accessories (e.g., seats, brake levers, and pedals). However, the two major advances are in the frame and wheels.

The use of carbon-fiber-reinforced composite frames has made the bicycles very light apart from keeping their frames stiff. Frames have recently been produced from magnesium, aluminium, titanium, and metal-matrix composites as well. In addition, hybrid frames such as carbon-fiber-reinforced composites combined with titanium have been produced.

Wheels with increased stability and rigidity for off-road bikes constructed from glass-fiber-reinforced nylon and disc wheels have been constructed. In disc wheels, discs made of aluminium alloys or carbon-fiber-reinforced composites replace the spokes in conventional wheels. Developments also include three- or five-spoked wheels for rigidity and crosswind aerodynamics. Cycle spokes add to the drag because they whiz at twice your speed when at the top of the wheel. This is why racing bicycles often cover the spokes with a disk cover — but only on the rear wheel usually because crosswinds at the front can destabilize steering.



Futuristic Footwear

The resurgence in running brought about by the English in the 18th century meant the development of a lightweight shoe that could grip the ground. The nineteenth century saw the introduction of an all leather spiked running shoe. The need for greater speed in the modern games necessitated further refinement of lightweight shoes with improved traction. Competition shoes made from leather fitted tightly to the foot but because they were not waterproofed the leather stretched making them useless for running.

In 1832 Wait Webster patented a process whereby rubber soles could be attracted to the shoes and boots. By the

The modern 'Hasket' ball came over only hundred years ago, where there was a rubber-core, a solid one, bound with rubber thread. This was enclosed in a dimpled case of 'balata'—a type of non-elastic latex. The Hasket balls had an advantage over the experimentally introduced pneumatic balls, as they never exploded on hot days!

From about 1700, cricket balls also followed the same technology with leather sewn around a rounded hard core made out of cork, remaining a standard, unchanged through the 19th century.

Historians believe that the game of football is as old as human civilization. Chinese and South Americans kicked around something similar to a sphere, but it was not until the first rubber bladder appeared in 1862 that the game of soccer became a serious sport. Before that 'football' was largely an inflated animal bladder, often protected by an outer skin of leather. The first "balls" were not round, as bladders were not so, that which is still used in American Football and Rugby. However there were no regulations concerning the ball until 1872, being formulated by FA (Football Association) in England which was founded in 1863.

Strangely through the many years it passed the soccer ball changed little.

Camera in the sky keeps an eye on the proceedings

During the 1996 World Cup cricket matches, millions of viewers watched as field umpires took the aid of the third umpire before taking a decision on close run-outs and stumpings.

1860s a croquet shoe was marketed which had a rubber sole with a canvas upper fastened with laces. Movement in the shoes was noiseless and quickly worn by sneak thieves hence the name sneakers.

Specialty shoes for the bicycle boom of the 1860s and 70s meant the introduction of heel less shoes for cyclists. These were lightweight and had eight or ten eyelets.

Spiked shoes for running were developed in 1852. Joseph William Foster founded the first sports shoe company in Boulton (United Kingdom) in the 1890's. His grandson later took over in 1958 and renamed the firm, Reebok. In the 1924 Olympics, the company made thin shoes made from rigid leather. In 1907 one company began stitching a leather strip round the top of the shoe to form a collar, and this helped to reduce stretching. The first popular sneaker was introduced in the United States in 1917 under the name of Keds. These were tennis shoes. The popularity of tennis in the 1920s meant many adults wore canvas-topped shoes for recreation.

The father of the modern running shoe was Adolf Dassler who began making shoes in 1920. By 1936 his shoes were internationally acknowledged as the best and were worn by athletes of the calibre of Jesse Owens. Dassler's running shoes were worn at the Berlin Olympics. Dassler specialised in shoes designed for sport. After the lean war years he continued to progress and developed the training shoe made from surplus tent canvas and rubber from fuel tanks. In 1948 he founded Adidas but the company was soon to split into Adidas and Puma. To give support to the running shoe Dassler added three side strips to the shoe, which first appeared in 1949.

It wasn't until the 1960s and 70s that technology really took off. In the 70s science began to take a much bigger role, as manufacturers involved podiatrists (foot experts) in their product development. Nowadays modern synthetic shoes are made of lightweight mesh fabric uppers and lightweight synthetic soles chosen for maximum flexibility and comfort. Running shoes have no heel and this provides the necessary leverage for toe spring, which propels the runner's legs forward.

Whether it's foam, silicon, air or gel, cushioning systems have become one of the most important aspects of the modern running shoe. The 70s saw the development of ethylene vinyl acetate (EVA) - a substance made up of millions of tiny air bubbles that provides cushioning and absorbs shock. It was considered to be a major advance in footwear technology and is still widely used today.

And now space age shoes are also here. The smart shoes have a liquid crystal display system. When plugged into a personal computer they can tell the distance covered, time taken and the calories burned after each run!

The dramatic effect of technology is more evident in pole-vault when bending bamboos were replaced by Aluminium in 1957.

Apart from adding a layer of cloth between the bladder and leather casing everything remained the same. The modern alteration was the interlocking panels replacing the traditional 18-section exterior of stitched and tanned cowhide. The main problem was the leather balls absorbing water in damp conditions, becoming heavy and making "heading" a dangerous exercise.

In modern balls, movement in straight line is preferred to added distance. The number, size and optimum spacing of dimples along with the weight of the hardcore was found to affect distance travelled, whereas a three-layer ball with a polyurethane exterior created a low flying and slow spinning ball. When the physicists went on to work on the football, FIFA – the international body controlling the game – eagerly established a standard size, pressure, shape retention and bounce and weight characteristics for it. Coloured balls were permitted for the benefit of TV but it regulated the materials from which it could be made.

The first synthetic (Polyurethane) ball was used in World Cup 1986. The maximum permitted weight gain through moisture absorption was fixed as 10% but the 2006 World Cup ball never gained more than 0.1% of its weight. The improved water resistance was achieved by replacing the traditional stitching of the panels with thermal bonding. The much-evolved modern first-class football also has surface interruptions to maximise the friction between itself and the boot. The number of panels also has been reduced, from 32 to 14.

The Winner's Fabric

Sporting apparel first came to the field in the form of protective wear. In cricket, the batsman was wearing 'leg-guards' even from the days of the 19th century. But, the technology was basic involving canvas, leather, horsehair, and wood enforced cotton paddy. Wicket keepers often laced the inside of their gloves with meat to protect their hands. Footballers took to wearing shin-pads, especially players of American football. Helmets were worn by some since the 1890s and it became compulsory by 1930s, but nothing for the head of cricketers, as the England batsman Derek Randal ironically put it, when hit by a ball on his head, "No good hitting me there mate, Nothing to damage!"

The majority of man-made sports-wear appeared for the first time after World War II. Rayon and Nylon paved the way for acrylic (1950), Polyester (1953), Spandex (1959) and more recently Lyocell in 1992, which is claimed to be environment friendly. The first advantage of technologically produced fabrics is weight, especially when wet. Traditional natural fabrics like wool, cotton and even Nylon are hydrophilic in nature.

On the other hand, Polyester, which is the main ingredient of most of modern sports garments, is very much hydrophobic, that is, it does not absorb water. According to sports physicians, wet fabrics could have serious implications such as hypothermia when the body is unable to generate sufficient warmth or can induce wasting of energy. Even Polyester has a clear disadvantage of building-up body temperature in hot conditions.

Technology had several answers for this, the most popular being "breathing fabrics" sold under the name "Gore-Tex" and "PB2". Simply speaking, they are impervious to rain but allow moisture (sweat) to pass through. Their effectiveness in shifting moisture from

During the first test of the Australia and England Ashes series in 1979-1980, Australia's fast bowler Dennis Lillee came to the wicket carrying a "brand-new" shining bat. When he drove the ball from England paceman Ian Botham, everybody heard an odd sound—a big clang! It was a blow sure enough to warrant a four but Lillee could run only three runs.

inside to out is measured as MVT (Moisture Vapour Transfer).

The latest technology in sports-fabric is however PCM-fabric made from "Phase Change Materials." They usually incorporate highly hydrophobic fibres like 'Ingeo' or 'Olefin'. Worn next to the skin as "under armour", they help keep the body at constant temperature, cool in hot conditions and warm in cold climate. The material remains in the gel-state and when they attain a high temperature, they change the 'phase' by absorbing the heat. When the temperature around them falls, they release their stored heat and return to the gel state.

Another virtue of modern man-made fabrics is that they can be quick wicking, that is, capable of soaking in sweat and removing it from the body. An athlete can feel more comfortable with a wicking garment and moreover with some anti-microbial element it can combat fungal infections too.

It would not be an exaggeration to say that technology of sports clothing could even enhance fair play. A shirt made up of Spandex material can stretch up to 600% and when the defender is blocked by grabbing his shirt, there is greater chance of the referee seeing it, as the stretched shirt will be a sure evidence of the offence!

Spandex is a form of polymer, invented by the DuPont chemist Joseph Shivers in 1959. It was initially known by the name "Elastane." Today, it is popular as "Lycra". The specialty of Spandex is that it combines the stretchability of rubber and toughness of Polyurethane. It is one of the wonders of modern sportswear that Polyurethane and Spandex combine in the manufacture of high-grade garments that have to endure constant stress and strains. Spandex undergarments are supposed to remove lactic acid from muscles, dampen muscle vibration and facilitate blood flow. Recently spandex has been added to football jerseys.

Spears and Poles

The athletic activity that clearly displays the complex relationship between sports and technology is Javelin throw. Originally it was a shaft of Olive wood, being replaced by the Hickory or Scandinavian Birch, but metal tipped spear or the 'real' Javelin came only in the 1896 Olympics. Though the weight was standardised as 800 g and length 2.6 m, a major revolution swept through when Richard Held introduced the hollow Javelin of Steel and Aluminium. Held was able to increase the surface area by 27% while keeping the weight same, enabling the Javelin to literally "fly" to record making distances.

But when East Germany's Uwe Hohn made a truly extraordinary performance of 104.80 m, beating the previous record by an astounding 5 m, IAAF (International Association of Athletics Federations) moved the 'centre of gravity' of competing Javelins forward by 4 cm. It proved to have a double effect—shorter distances and nose hitting, making distance measurement easier.

The dramatic effect of technology is more evident in pole-vault when bending bamboos were replaced by Aluminium in 1957. The 1896 Olympics saw a height of ten feet, six inches achieved with a bamboo pole. In the 1960s, after the pole-vault record had inched upwards for 60 years, records began to fall as aluminum poles were introduced. Today, world-class pole-vaulters are using highly sophisticated composite pole, resulting in the 1996 record of 19 feet, five inches.

Now pole-vaulters use a highly flexible fibreglass pole, thanks to the minimal regulations imposed by IAAF on pole specifications. Physicists have realised that hollow poles are better than solid ones and tapering poles are better than parallel ones. As the vault is achieved by releasing the stored strain energy in the bent pole, there was enough scope for basic sports research as pioneered by University of Cambridge. Researchers say that in pole-vaulting it is impossible to separate technique from apparatus.

The latest technology includes the incorporation of piezoelectric crystals into racket frames, which produce electricity under stress. The current generated by the ball hitting the strings is sent to the handle, amplified and returned to the ceramic composites in the frame. This causes the frame to stiffen and the result can be greater power and less vibration.

Technology at Play

During the 1996 World Cup cricket matches, millions of viewers watched as field umpires took the aid of the third umpire before taking a decision on close run-outs and stumpings. What's more, they did not need to rush over to the pavilion at all. They stayed in contact thanks to small portable walkie-talkies they carried. However, the third umpire is only one of the several technological inputs that have become indispensable in today's sports world. Technological gadgetry has intruded into almost every aspect of game play today.

For instance, Steven's Machine, named after its inventor, is a simple mechanical device that is used to measure the amount of deformation attained by a tennis ball under a previously known amount of force. Here, the ball is pressed between two plates and the readings are recorded automatically. Today, there are four types of tournament balls each differing in size and rebounding capacity. According to the nature of the court surface and attitude, ball type is selected, where testing by Steven's machine plays a major role.

Then there is the Snickometer, a technological assistance provided to umpires and commentators that makes judgment easier. It was invented by the computer expert Allan Plaskett. The working is based on sounds picked up by microphones located in the stumps or pitch, which is reproduced as an oscillation chart, depicting the ball passing the bats. Useful in LBW related disputes.

Hawkeye is a British invention derived from missile-tracking technology that is used to recreate the trajectory of a moving ball with 99.99% accuracy. It works on a set of six wirelessly linked cameras, set in different positions in the playing area. With the help of a computer program, it can also predict the path of the ball, if it goes uninterrupted. 'Skyscope' also functions similar to Hawkeye.

Many of us have wondered over the amazingly detailed statistics flashed upon our TV Screens, for example – 'Distance covered by 'X' during the match is 8,426 m'. Such wonders have been made possible through sports-tracking systems like the well known 'Pro-Zone'. Here, an array of digital cameras tracks the movement of the ball and each player behind it. The impulses are then fed to a computer system that gives positional breakdown every 0.01-second. This means that coaches, experts and players can recall almost everything of the overall performance. This type of video playback is now widely used for skill improvement also. Top performers are filmed demonstrating a skill, which is broken down to analyse its style and tactics. An example is "Sports Wizard" developed by Dartfish.

The automated boxing scoring system (ABSS) is a research and development project being developed by a group of Australian institutions and private companies. The system uses wireless communication, micro sensors, smart integration, and computer scoring to encourage accuracy and safety in boxing. The system allows monitoring of performance in real-time and is able to indicate the location of hits, display basic statistics on hit locations, and show the current score of each boxer.

There is no doubt that technology has been changing sports, from the moment toe-hold groves were inserted in ancient Olympics to the potentially revolutionary "dee-three-oh" protective ski clothing. But more than that the nature of sports itself is changing. Over the last 20 years, sports has evolved into an industry.

Scientists, engineers, technicians, trainers and coaches are striving to give their athletes a slight edge, that could make the difference between winning a medal and going back empty handed.

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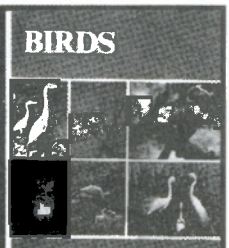

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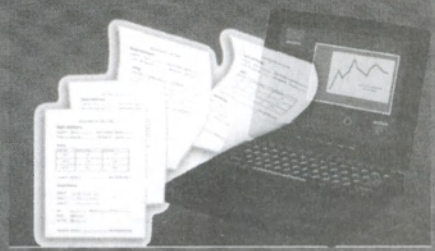

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Top Tennis Players Simply See Better

For most of us mere mortals, if an object was coming at us at 120-150 mph, we would be lucky to just get out of the way. Top ranking players not only see the ball coming at them with such speed, but plan where they want to place their return shot and swing their racquet in time to make contact. At 125 mph from 78 feet away, that gives them a little less than a half second to accomplish the task.

How do they do it? Swiss researchers have concluded that expert tennis players have an advantage in certain visual perception skills, while UK scientists have shown how trained animals — and presumably humans — can rely on a superior internal model of motion to predict the path of a fast moving object.

For any sport that involves a moving object, athletes must learn the three levels of response for interceptive timing tasks. First, there is a basic reaction, also known as optometric reaction (in other words, see it and get out of the way). Next, there is a perceptual reaction, meaning you actually can identify the object coming at you and can put it in some context (for example: That is a tennis ball coming at you and not a bird swooping out of the sky). Finally, there is a cognitive reaction, meaning you know what is coming at you and you have a plan of what to do with it (return the ball with top-spin down the right line).

This cognitive skill is usually sport-specific and learned over years of tactical training. Obviously, professional tennis players are at the expert cognitive stage and have a plan for most shots. But, in order to reach that cognitive stage, they first need to have excellent optometric and perceptual skills.

Leila Overney and her team at the Brain Mind Institute of Ecole Polytechnique Federale de Lausanne (EPFL) studied expert tennis players and found that speed processing and temporal processing is often faster and more accurate in tennis players. They even scored better then their peers, the triathletes.

Still, are the tennis players really just relying on their visual advantage when given that half second to react? Have their years of practice created an internal cognitive model that anticipates and predicts the path of an object?

Nadia Cerminara of the University of Bristol (UK) designed an experiment that taught household cats to reach with their paw at a moving target. If they successfully touched the target, they received a food reward.

After training the cats to be successful, she recorded their neuronal activity in their lateral cerebellum. Then, she measured

Barefoot Running

New research is casting doubt on the old adage, "All you need to run is a pair of shoes." Scientists have found that those who run barefoot, or in minimal footwear, tend to avoid "heel-striking," and instead land on the ball of the foot or the middle of the foot. In so doing, these runners use the architecture of the foot and leg and some clever Newtonian physics to avoid hurtful and potentially damaging impacts, equivalent to two to three times body weight, that heel-strikers repeatedly experience.

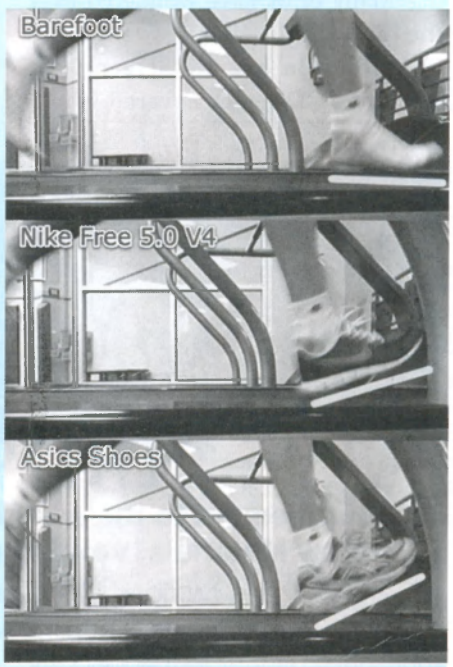
Most people today think barefoot running is dangerous and hurts, but actually you can run barefoot on the world's hardest surfaces without the slightest discomfort and pain. All you need is a few calluses to avoid roughing up the skin of the foot. Further, it might be less injurious than the way some people run in shoes.

Working with populations of runners in the United States and Kenya, Lieberman and his colleagues at Harvard, the University of Glasgow, and Moi University looked at the running gaits of three groups: those who had always run barefoot, those who had always worn shoes, and those who had converted to barefoot running from shod running. The researchers found a striking pattern.

Most shod runners – more than 75% of Americans – heel-strike, experiencing a very large and sudden collision force about 1,000 times per mile run. People who run barefoot, however, tend to land with a springy step towards the middle or front of the foot.

"Heel-striking is painful when barefoot or in minimal shoes because it causes a large collisional force each time a foot lands on the ground," says co-author Madhusudhan Venkadesan, a postdoctoral researcher in applied mathematics and human evolutionary biology at Harvard. "Barefoot runners point their toes more at landing, avoiding this collision by decreasing the effective mass of the foot that comes to a sudden stop when you land, and by having a more compliant, or springy, leg."

"Our feet were made in part for running," Lieberman, another co-author, says. "Humans have engaged in endurance running for millions of years, but the modern running shoe was not invented until the 1970s. For most of human evolutionary history, runners were either barefoot or wore minimal footwear such as sandals or moccasins with smaller heels and little cushioning."



For modern humans who have grown up wearing shoes, barefoot or minimal shoe running is something to be eased into, warns Lieberman. Modern running shoes are designed to make heel-striking easy and comfortable. The padded heel cushions the force of the impact, making heel-striking less punishing.

"Running barefoot or in minimal shoes is fun but uses different muscles," says Lieberman. "If you've been a heel-striker all your life you have to transition slowly to build strength in your calf and foot muscles."

(Courtesy: www.sciencedaily.com)

(Courtesy: www.sciencedaily.com)

the activity again but would block the vision of the cats for 200-300 milliseconds while performing the task. Despite the lapse in visual information, the neuron firing activity remained the same as before. Cerminara concluded that an internal model had been used to bridge the gap and provide a prediction of where the object was headed.

So, when faced with a blistering serve, science suggests that players like Federer not only rely on their superior perceptual skills, but also have created an even faster internal simulation of a ball's flight that can help position them for a winning return.

Short Heels Add Super Speed

Longer toes and a unique ankle structure provide sprinters with the burst of acceleration that separates them from other runners, according to biomechanists.

"At the start of a sprint the only way a runner can speed up is through the reaction force that results from the action of leg muscles pushing on the ground," said Stephen Piazza, associate professor of kinesiology, Penn State. "Long toes provide sprinters the advantage of maintaining maximum contact with the ground just a little bit longer than other runners."

Piazza and his colleague Sabrina S. M. Lee matched 12 collegiate sprinters with 12 non-athletes of the same height. They measured the distance between the heel and the end of the toes and used ultrasound imaging to measure the sliding of the Achilles tendon during ankle motion, from which the leverage of the tendon can be calculated.

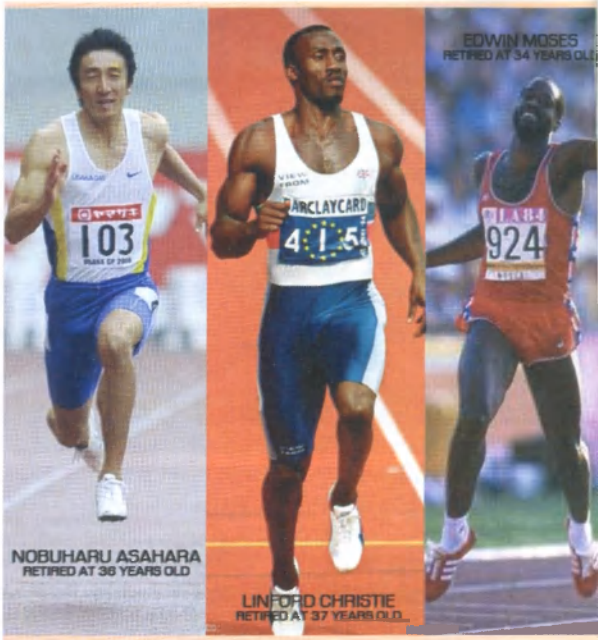
"What we found was that the lever arms (distance between the tendon and center of rotation of the ankle) were significantly shorter — about 25 percent shorter — in sprinters," said Piazza, whose findings appeared recently in the *Journal of Experimental Biology*. "This difference might be explained by a tradeoff between leverage and muscle force-generating capacity."

Because the lever arms are shorter, the muscles shorten less for the same joint rotation. If muscles shorten less, they shorten more slowly, which helps them to produce greater force that more than compensates for the reduced leverage.

Piazza cites other recent research suggesting that shorter toes in modern humans could be an evolutionary adaptation for efficient distance running.

"Maybe our ancestors with longer toes were better sprinters. Or maybe longer toes were selected for at a time when navigating in trees was more important and our toes became shorter as endurance running became more important for our survival," he added.

(Courtesy: www.sciencedaily.com)



Taller Athletes Are Faster

A new research coming out of Duke University has showed that sprinters and swimmers who are taller, heavier but more slender are the ones breaking world records.

At first glance, it may not make sense that bigger athletes would be faster. However, Jordan Charles, a recent engineering grad at Duke, plotted all of the world record holders in the 100 meter sprint and the 100 meter swim since 1900 against their height, weight and a measurement he called "slenderness."

World record sprinters have gained an average of 6.4 inches in height since 1900, while champion swimmers have shot up 4.5 inches, compared to the mere mortal average height gain of 1.9 inches. During the same time, about 7/10 of a second have been shaved off of the 100-meter sprint while over 14 seconds have come off the 100-meter swim record.

For locomotion, a human needs to overcome two forces, gravity and friction. First, an athlete would need to lift his foot off the ground or keep his body at the water line without sinking. Second, air resistance for the sprinter and water resistance for the swimmer will limit speed.

So, the first step is actually weight lifting, which a bigger, stronger athlete will excel at. The second step is to move through the space with the least friction, which emphasizes the new slenderness factor.

By comparing height with a calculated "width" of the athlete, slenderness is a measurement of mass spread out over a long frame. The athlete that can build on more muscle mass over an aerodynamic frame will have the advantage. As the athletes' slenderness factor has risen over the years, the winning times have dropped.

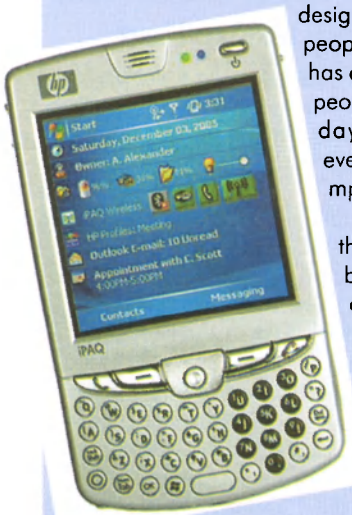
(Courtesy: www.sciencedaily.com)

World Walking Record—By a Robot!

A Cornell University robot named *Ranger* walked 14.3 miles in about 11 hours, setting an unofficial world record at Cornell's Barton Hall. Ranger navigated 108.5 times around the indoor track in Cornell's Barton Hall – about 212 meters per lap, and made about 70,000 steps before it had a stop and recharge. The 14.3-mile record beats the former world record set by Boston Dynamics' *BigDog*, which had claimed the record at 12.8 miles.

Cell Phone that Motivates you to Exercise

Chinmay Manohar in the Department Endocrinology, Nutrition and Diabetes of the Mayo Clinic is designing a device to help motivate people to be more active. His team has developed a program that helps people monitor their normal day-to-day physical activity using an everyday device like a cell phone or mp3 player.



Manohar's team settled on the iPhone® and the iPod Touch® because many people already own these devices and they come with built in motion sensors. The research group created a program called the Walk n'Play that can be downloaded for free through iTunes® to distribute the technology to a wider population. More and more Smart phones are using motion sensors and making the program compatible between platforms will not be difficult.

The current version is fairly basic, according to Manohar. The user inputs their height and weight into the program and throughout the day, their score can be monitored. The program will tell the user if they are winning or losing against the computer. There is no pressure and the game does not ask you to do any specific exercise. But turning physical activity into a game makes people more competitive and more likely to get active.

The iPhone® and the iPod Touch® use motion sensors called accelerometers that detect motion. The program is designed to access the accelerometer in the phone and convert the motion that is detected into activity units as a way to measure the physical activity.

The group further modified the program to integrate basic social networking. Fitness and weight-loss in general is easier to do with a buddy. The newer features will allow a person to play against their friends or even compete with people or top performers from other countries or time zones. Users can even post their performance as their Twitter status.

News Briefs

■ In the split second before foot meets ball, a soccer player's body betrays whether a penalty kick will go left or right, according to recent research in cognitive science at Rensselaer Polytechnic Institute. The findings could explain how some top goalkeepers are able to head off a penalty kick, diving in the correct direction in advance of the kick. It could also point the way to changes in how players kick, and goalies react. The research employed motion capture technology and computer analysis to identify five early indicators of the direction a ball would ultimately be kicked.

■ Physics experts at the University of Adelaide believe the new ball created for the 2010 World Cup, called the *Jabulani*, will play "harder and faster," bending more unpredictably than its predecessor. The *Jabulani* is textured with small ridges and 'aero grooves' and represents a radical departure from the ultra-smooth *Teamgeist* ball, which was used in the last World Cup. By comparison, the aerodynamic ridges on the *Jabulani* are likely to create enough turbulence around the ball to sustain its flight longer, and be a faster, harder ball in play. It is expected to 'bend' more for the players than any ball previously encountered.

■ Researchers in New Zealand have developed a new type of wearable impact sensor that can provide much needed information about the stresses and strains on limbs for rugby players, high jumpers, and runners. A novel material known as ionic polymer metallic composites (IPMCs) produces an electrical current when compressed. These wearable sensor devices allow sports scientists to monitor directly impact forces without interfering with an athlete's performance. Impact sensors made from IPMC could be inserted into footwear or they might be placed in a rugby player's shoulder pads.

■ Both recreational skiers and elite ski racers can forget about wax and scrape their skis with a steel tool instead. Modern ski bases provide better glide. It's enough to treat the surface of the ski mechanically, using a steel scraper, for example, to achieve good glide. This also minimizes the cost as well as the time spent. The gliding surface of modern cross-country skis is made of ultra-high molecular weight polyethylene (UHMWPE). It is a material that offers extremely good wear characteristics, a low coefficient of friction, and the capacity to self-lubricate.

■ It was believed that competitive cyclists have significantly lower bone mineral density (BMD) than other endurance athletes, making them more susceptible to fractures. One explanation is an imbalance between bone formation and bone breakdown due to the high-energy cost of stage racing. However, a new study reveals that proper nutrition during multi-day stage races might prevent harmful changes in bone turnover. Researchers found that athletes who maintained energy balance by matching their energy intake to their energy expenditure showed increased markers of bone turnover – the process of breaking down old bone and forming new bone.

■ The popularity of weight training has grown over the past decade. A new study conducted by the Center for Injury Research and Policy of The Research Institute at Nationwide Children's Hospital has found that the number of injuries from weight training has increased as well. Data from the study, available online showed that males (82%) and youths aged 13 to 24 years (47%) sustained the largest proportion of weight training-related injuries. The majority of injuries occurred during the use of free weights (90%), and the most common mechanism of injury were weights dropping on a person (65%). Injuries to the upper (25%) and lower trunk (20%) were the most common followed by injuries to the hand (19%).

JAIMINI SARKAR

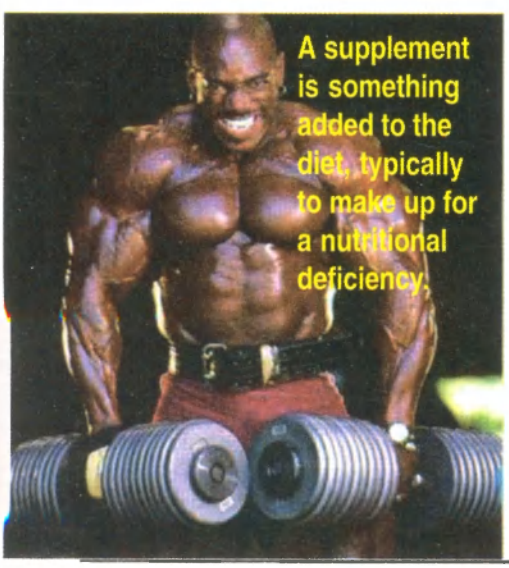
Sports Nutrition Maximising Performances

Sportspersons need a carefully designed diet regimen. Athletes can hope to perform well only with adequate reserves of strength at their diposal.

SINCE the time the ancient Greeks and Romans started the Olympic games, athletes have had their own special regimen to come up with great performances, which included diet and nutrition too. For instance, Milo of Croton, the wrestler with legendary strength who won five successive Olympic Games from 532 to 516 B.C., ate 9 kg of meat, 9 kg of bread and 8.5 litres of wine a day!

Alcohol was commonly drunk as an ergogenic aid to increase performance in the Olympics through the early 1900s. However, the view of sports nutrition today has much evolved from the ancient Olympic gladiators' meal plan.

In fact, sports nutrition has emerged as an independent field in itself comprising the study and practice of nutrition and diet as it relates to athletic performance. It is concerned with the type and quantity of fluid and food taken by an athlete, and deals with nutrients such as vitamins, minerals, supplements and organic substances such as carbohydrates and proteins. Although sports nutrition is an important part of many sports training regimens, it is most commonly considered in strength sports (weight lifting and bodybuilding) and endurance sports (cycling, running, triathlon).



Enhancing performance is the primary goal of sports nutrition and this it does by various ways. First, it improves performance by improving body composition, which increases speed, quickness, mobility, and strength. Second, it helps the speed of recovery, which will in turn create more capacity for practicing and competition as the body becomes more fit and adjusted to the good nutrition incorporated into the workout regimen. Third, it helps to increase energy for both practice and competition. Strategic diet also increases immunity, allowing one to stay healthy and be able to continue and intensify practice and training.

Nutrients are generally broken into three classes: Carbohydrates, Fats and Proteins. Each category is equally important. However, the ratio in which athletes need to consume these foods is often the topic of debate.

Carbohydrates – Main Fuel Source

Carbohydrates are arguably the most important components that provide energy to fuel muscle contractions. Once eaten, carbohydrates break down into smaller sugars (glucose, fructose and galactose) that get absorbed and used as energy. Any glucose not needed right away gets stored in the muscles and the liver in the form of glycogen. Once these glycogen stores are filled up, any extra carbohydrate gets stored as fat.

Glycogen is the source of energy most often used for exercise. It is needed for short, intense bouts of exercise from sprinting to weight lifting because it is immediately accessible. Glycogen also supplies energy during the first few minutes of any sport. During long, slow duration exercise, fat can help fuel activity, but glycogen is still needed to help break down the fat into something the muscles can use.

Adequate carbohydrate intake also helps prevent protein from being used as energy. If the body doesn't have enough carbohydrate, protein is broken down to make glucose for energy. Carbohydrate has other specific functions in the body including fueling the central nervous system (CNS) and brain.

One gram of carbohydrate provides four calories of energy. Athletes often talk about carbohydrate loading and carbohydrate depletion which refers to the amount of carbohydrate energy we can store in our muscles. This is generally around 2,000 carbohydrate calories, but this number can be changed through depletion and loading. During depletion (from diet, exercise or a combination) the stored carbohydrate is used.

If we don't replenish these stores, we can run out of fuel for immediate exercise. Athletes often refer to this as bonking or hitting the wall. In the same way, eating large amounts of

Sportspersons should keep in mind that their performance on the field would, for the most part, also depend on the diet they take and when they take.

carbohydrates can increase these stores, referred as carbohydrate loading or carbo-loading. Our maximal carbohydrate storage is approximately 15 grams per kilogram of body weight (15 grams per 2.2 pounds). So, a 175-pound athlete could store up to 1200 grams of carbohydrate (4,800 calories)—enough energy to fuel high intensity exercise for quite some time.

Carbohydrate stored as glycogen is an easily accessible source of energy for exercise. How long this energy supply lasts depends on the length and intensity of exercise and can range anywhere from 30 to 90 minutes or more. To avoid running out of energy during exercise, the athlete starts with full glycogen stores, replenishes them during exercise and refills them after exercise to be ready for the next workout.

Carbohydrates are also divided into simple and complex forms. Simple sugars (carbs) are absorbed and converted to energy very quickly and provide a rapid source of energy. Fruit and energy drinks are a good source of simple carbohydrates.

Complex carbohydrates take a bit longer to be digested and absorbed into the body. They also take longer to break down and therefore provide energy at a slower rate than simple sugars. Examples of complex carbohydrates are breads, rice and pasta. Starch and fiber are also considered complex carbohydrates but fiber can not be digested or used for energy. Starch is probably the most important energy source in an athlete's diet because it is broken down and stored as glycogen. Foods high in starch include whole grain breads, cereals, pasta, and grains.

Proteins for Repair

Athletes need proteins primarily to repair and rebuild muscle that is broken down during exercise and to help optimize carbohydrate storage in the form of glycogen. Protein is not an ideal source of fuel for exercise, but can be used when the diet lacks adequate carbohydrates. This is detrimental, though, because if used for fuel, there isn't enough available to repair and rebuild body tissues, including muscles.

Complete proteins (those containing eight essential amino acids) come mostly from animal products such as meat, fish, and eggs and incomplete proteins (lacking one or more essential amino acids) come from sources like vegetables, fruits and nuts. Vegetarian athletes may have trouble getting adequate protein if they aren't aware of how to combine food.

The average adult needs 0.8 grams of proteins per kilogram (2.2lbs) of body weight per day. Strength training athletes need about 1.4 to 1.8 grams per kilogram (2.2lbs) of body weight per day. Endurance athletes need about 1.2 to 1.4 grams per kilogram (2.2lbs) of body weight per day.

Food	Amount	Protein (gms)
Fish	3 oz	21
Chicken	3 oz	21
Meat	3 oz	21
Milk	8 oz	8
Yogurt	8 oz	8
Cheese	3 oz	21
Peanut butter	2 tbsp	8
Eggs	2 large	13

Energy from Fats

Fats provide the highest concentration of energy of all the nutrients. One gram of fat equals nine calories. This calorie density, along with our seemingly unlimited storage capacity for fat, makes fat our largest reserve of energy. While these calories are less accessible to athletes performing quick, intense efforts like sprinting or weight lifting, fat is essential for longer, slower, lower intensity and endurance exercise. Even during high intensity exercise, where carbohydrate is the main fuel source, fat is needed to help access glycogen.

Converting stored body fat into energy takes a great deal of oxygen, so exercise intensity must decrease for this process to occur. For these reasons, athletes need to carefully time when they eat fat, how much they eat and the type of fat they eat.

What an athlete consumes before, during and after exercise is important for enhancing performance.

Eating for Exercise

While eating soon before exercise doesn't provide the bulk of the fuel needed for the activity, it can prevent the distracting symptoms of hunger during exercise. The major source of fuel for active muscles is carbohydrate

which gets stored in the muscles as glycogen in the days before exercise.

Pre-exercise meal: Exercising on a full stomach is not ideal. Food that remains in your stomach during an event may cause stomach upset, nausea, and cramping. To make sure you have enough energy, yet reduce stomach discomfort, you should allow a meal to fully digest before the start of the event. This generally takes 1 to 4 hours, depending upon what and how much you've eaten. Each one of us is a bit different, and you should experiment prior to workouts to determine what works best for you.

If you have an early morning race or workout, it's best to get up early enough to eat your pre-exercise meal. If not, you should try to eat or drink something easily digestible about 20 to 30 minutes before the event. The closer you are to the time of your event, the less you should eat. You can have a liquid meal closer to your event rather than a solid meal because the stomach digests liquids faster.

Because glucose is the preferred energy source for most exercises, a pre-exercise meal should include foods that are high in carbohydrates and easy to digest, such as pasta, fruits, breads, energy bars and drinks.

Post-exercise meal: The first nutritional priority after exercise is to replace fluid lost during exercise. It is also important to consume carbohydrates such as fruit or juice within 15 minutes post-exercise to help restore glycogen. Research has shown that eating 100-200 grams of carbohydrate within two hours of endurance exercise is essential for building adequate glycogen stores for continued training.

Waiting longer than two hours to eat results in 50% less glycogen stored in the muscle. The reason is, carbohydrate consumption stimulates insulin production, which aids the production of muscle glycogen. Combining protein with carbohydrate in the two hours after exercise nearly doubles the insulin response, which results in more stored glycogen. The optimal carbohydrate to protein ratio for this effect is 4:1 (four grams of carbohydrate for every one gram of protein). Eating more protein than that, however, has a negative impact because it slows rehydration and glycogen replenishment.

Consuming protein after exercise provides the amino acids necessary to rebuild muscle tissue that is damaged during intense, prolonged exercise. It can also increase the absorption of water from the intestines and improve muscle hydration.

Planning for the Competition

Planning is essential if athletes are competing in an all-day event, such as track meets or other tournaments. Consider the time of event, the amount of meal and the energy required. Also, be aware of the amount of fluid one consumes. One should plan ahead and prepare meals and snacks that have been tried before. Do not experiment with something new on the day of the event.

1 hour or less before competition
Fresh fruits such as apples, watermelon, peaches, grapes, or oranges and/or, energy gels, up to 1 ½ cups of a sports drink

2 to 3 hours before competition
Fresh fruits, bread, bagels, pasta, yogurt, water

3 to 4 hours before competition
Fresh fruit, bread, bagels, pasta with tomato sauce, baked potatoes, energy bar, cereal with milk, yogurt, toast/bread with a bit of peanut butter, lean meat, or cheese, water

Foods to avoid before exercise/ competition
Any food with a lot of fat like meats, doughnuts, fries, potato chips, and candy bars

Tips for Vegetarian Athletes

Vegetarians must take extra care to avoid deficiencies of iron, zinc, and vitamin B12, which can hurt exercise and strength training performance. One can get enough protein by eating plenty of low-fat dairy products (milk, yogurt, cheese etc.) and protein-rich plant sources, like soy and peanut butter.

Heme iron is a type of easily absorbed iron that is found in animal protein. If you eat fish or chicken, you will get this type of iron, but if you do not eat meat, you will need to find other sources of iron. Our bodies don't absorb non-heme iron (found in vegetables) as easily as the iron that comes from animal foods.

Non-meat eaters, especially female athletes, must pay attention to their dietary iron needs. Good sources of non-heme include wholegrain cereals, leafy green vegetables, figs, lentils and kidney beans, and some dried fruits. Some foods like coffee, whole grains, bran, legumes, and spinach contain substances that block the absorption of iron in the intestine hence they should be combined with vitamin C to increase iron absorption.

Because vitamin B12 is available only from animal products, it is one of the most common nutrients missing from the diets of vegetarian athletes. To get enough B12 (2.4 micrograms per day) try to eat B12-fortified foods like soymilk, cereal, cheese, milk and yogurt.

Eating for Endurance

Athletes who compete in endurance events often do not want to eat during competitions, although replacing depleted carbohydrate stores (muscle glycogen) is essential to continue high intensity exercise. To solve this problem, many athletes have begun using energy gels as a source of easy to consume carbohydrates.

Most gels show a similar glycemic response when compared to liquid or solid foods with the same amount of carbohydrates, although the liquid and gel carbohydrates induce a slightly faster rise in glucose in the first 15 minutes of exercise with a corresponding increase in insulin that is higher with the liquid carbohydrate.

An energy gel composed of 25 g of carbohydrate taken with 200 ml of fluid is able to maintain blood glucose levels during a two hour run at 70% of VO_2 (maximal oxygen uptake) when compared to a placebo. While it appears that gels may be effective in providing energy for exercise, the biggest challenge may be taking in enough fluid along with them. If athletes don't drink enough water when consuming a gel they risk slowing down the absorption of both the carbohydrate and water.

Eating for Strength

In order to build lean muscle mass you need to combine an adequate calorie intake with a solid muscle strengthening programme. Experts recommend at least 500 to 600 g of carbohydrate per day to keep muscle

One gram of carbohydrate provides four calories of energy. Athletes often talk about carbohydrate loading and carbohydrate depletion which refers to the amount of carbohydrate energy we can store in our muscles.

glycogen stores high. One can work out the requirement using the formula:

3.6 g carb x body wt (lbs) = grams carb/day
(2,900 carbohydrate calories for 200-pound person)

However, most strength athletes still overestimate their protein needs. Daily protein recommendations for strength athletes are about 0.6 to 0.8 grams per pound of body weight. That's about 128 to 164 grams for those weighing 200 pounds.

Most supplements that are supposed to help build muscle don't work. But some, such as creatine, fluid and electrolyte replacers, carbohydrate supplements, and liquid meal replacers may offer some benefits to strength training athletes.

Water and Sports Performance

Adequate fluid intake for athletes is essential for comfort, performance and safety. Studies have found that a loss of two or more percent of one's body weight due to sweating is linked to a drop in blood volume. When this occurs, the heart works harder to move blood through the bloodstream. This can also cause muscle cramps, dizziness, fatigue and even heat illness.

Although rare, exercisers are also at risk of drinking too much water and suffering from hyponatremia or water intoxication. Clearly, drinking the right amount of the right fluids is critical for performance and safety while exercising. Because there is wide variability in sweat rates, losses and hydration levels of individuals, it is nearly impossible to provide specific recommendations or guidelines about the type or amount of fluids athletes should consume.

Finding the right amount of fluid to drink depends upon a variety of individual factors including the length and intensity of exercise and other individual differences. There are, however, two simple methods of estimating adequate hydration. Monitoring urine volume output and colour. A large amount of light coloured, diluted urine probably means you are hydrated; dark coloured, concentrated urine probably means you are dehydrated.

The second method is weighing yourself before and after exercise. Any weight lost is likely from fluid, so try to drink enough to replenish those losses. Any weight gain could mean you are drinking more than you need. Consumption of beverages containing electrolytes and carbohydrates can help sustain fluid-electrolyte balance and exercise performance. It is better to increase salt intake per day several days prior to competition (except for those with hypertension), and try not to drink more than you sweat.

Generally, sodium containing sports drinks are used during long distance, high intensity events (more than 60-90 minutes long). During marathon a good rule of thumb is to drink about 1 cup of fluid every 20 minutes. In the days before the race, add salt to your foods (provided that you don't have high blood pressure and your doctor has not restricted your salt intake) and avoid use of nonsteroidal anti-inflammatory (NSAIDS) medicines that contain sodium as these drugs may predispose runners to hyponatremia.

Sports Drinks

Sports drinks are beverages designed to help athletes rehydrate, as well as restore electrolytes, carbohydrates, and other nutrients, which get depleted after training or competition. Electrolyte replacement promotes proper rehydration, which is important in delaying the onset of fatigue during exercise.

Sports drinks can be split into three major types: Isotonic sports drinks, Hypertonic sports drinks and Hypotonic sports drinks. Isotonic sports drinks contain similar concentrations of salt and sugar as in the human body. Hypertonic sports drinks contain a higher concentration of salt and sugar than the human body. Hypotonic sports drinks contain a lower concentration of salt and sugar than the human body.

Most sports drinks are moderately isotonic, having between 4 and 5 heaped teaspoons of sugar per five ounce (13 and 19 grams per 250 ml) serving. They never have a pH comparable to carbonated soft drinks.

Many sports drinks also reduce the risk of water intoxication by replenishing fluids and electrolytes in a ratio similar to that normally found in the human body. However, some sports drinks have low concentrations of electrolytes, so zealous overconsumption of these could also lead to water intoxication.

Sports Supplements

Athletes often look for alternative nutrition to perform their best. Supplements are a multi-million dollar business that offer some good and some unnecessary products. A supplement is something added to the diet, typically to make up for a nutritional deficiency. Ideally, it should be used as a substitute for eating well. Supplements include vitamins, amino acids, minerals, herbs and other botanicals.

Products classified as dietary supplements are not required to meet any Food and Drug Administration (FDA) standards. There are no regulations that guarantee the safety or purity of something sold as a supplement. So, supplements are not:

- required to meet the same safety requirements as over-the-counter or prescription drugs or food ingredients
- held to specific manufacturing standards
- guaranteed to meet product potency or purity ratings
- required to prove the effectiveness of any health claim they make
- required to meet safety or efficacy testing prior going to the market.

The FDA is prohibited from removing a product from the market unless it can prove that the product will cause a medical problem. Most health risks of supplements are discovered after the product is in the market. Supplements that are pulled from the market are usually linked to a reported serious health risk that is tied to the use of the product. So, ideally one should avoid sports supplements.

Those aspiring to be sportspersons should keep in mind that their performance on the field would, for the most part, also depend on the diet they take and when they take.

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"Sports Should be made Compulsory in Schools"

Sports Impart Character

Games are essential and a necessity for children. Physical exercise keeps the body fit and trim, thus ensuring healthy eating habits. If there are no games for children in school, they tend to get weary and bored of school routine, and studies become a drag. It has been shown that if you are overweight you are more likely to develop health problems, such as heart disease, stroke, diabetes, certain type of cancer, gout (joint pain) and gallbladder disease. Research has also shown that students taking part in sports have better academic performance than those who were not exposed to physical games. Games also boost character building and prepare children for leadership roles.

Outdoor games are recreational and ensure that children are exposed to fresh air and exercise, which they might not get at home, the television and the computer dragging them away from any forms of physical workout. Children also develop a coordination of eye and limbs. They learn to be more social and outspoken. They learn to deal better with their fears, think more independently and become apt at disregarding little bruises and fusses.

So, since outdoor games and sports open a door to freedom of mind, sports should be encouraged in all schools and should be supported by all parents, because the children of today are the hopes of tomorrow.

Owaiz Yusufi
Class VI, Career Convent College
Lucknow

Daily Dose of Sports

The first decision-making ability starts when a child steps on to the playground with friends. Sports activities bring out many qualities in a student. Since sports help them inhale more air/oxygen bringing strength to the body, the body grows healthy and the brain becomes sharper, thus helping the student to do well in studies as well. It will not be wrong to say that the physical, social and intellectual development of kids starts in the playground. Besides, due to lack of sports activities, students/kids gain weight, which is hazardous to their health. Sports are considered to be the most comprehensive exercise for kids. I think kids should be provided at least one sports period everyday to make them grow as happier, healthier and more responsible humans beings.

Vibhor Mudgil
Class VIII, DPS, Indirapuram

All Round Development

Education means all round development of personality i.e. physical, mental, aesthetic and spiritual. As children grow, they need balanced development of both the body and the mind especially up to the teens when they spend a major part of the day in school. At least one hour of sports of any kind is essential to recharge the minds of the children for better concentration. Schools are not for studies only. This narrow sense of education is to be corrected in the minds of the parents as well. Of course, sports and games would be followed by schools depending on the sports infrastructure they possess. In today's enclosed colonies with severe crunch of playing fields, sports in schools can be extremely beneficial for children.

Swapan Rudra
Sonamukhi, Bankura (W.B.)

Best Cure

Sports are like medicine for the health of children. Without improvement in health we can never build a good human being. So if sports are made compulsory for all then human health is protected by sports just like cancer is protected by chemotherapy. Also school is the first stage of health so it is the best time of taking treatment in the form of sports for total cure.

Md. Mahatab
Santiniketan (W.B.)

No Compulsion

No doubt, apart from studies, sports and exercises are also necessary for students, but making it compulsory means schools have to organize sports day anyhow otherwise it may be taken to task by the administration. So it will disrupt the study environment. Therefore, it should be left to the school management to hold sports events occasionally.

Shayan Ghani
Patna, Bihar

Develop a Sports Culture

I do not think there can be any counterpoint of this statement. Being a country that barely manages two or three medals in the Olympics, it should be mandatory for schools to provide sports facilities for students. This will not only kindle the passion for sports among students but will also create a sporty atmosphere in the whole of India. Coupled with this it will also address growing concern over health issues viz. obesity that is common among students going to schools, especially in urban areas.

Abhishek Anand
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Sports for a Healthy Body

To improve the power of thinking we need a healthy mind and a healthy mind demands a healthy body. Sports play an important role in keeping us physically fit. Today, with rapidly growing population and reducing numbers of playgrounds, students prefer to play computer and video games. In schools they are provided with proper facilities to play sports. But it should not be made compulsory. Instead we should try to make them interested in sports and this can be done by employing good sports teachers. Through sports our purpose is to make the students physically healthy and this will be possible only when they get interested in sports.

Dhritiman Kakati
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Some More Olympic Medals

Certainly, sport should be made compulsory in school. Not only on paper but also in practical terms. It will make children healthy not only physically but also mentally. It will also create a feeling of teamwork among them from their early childhood. There are a lot of games being

played outside our country about which majority of us do not know. If sports is made compulsory then we will get a chance to know about them, and if children develop interest in such games from their early childhood then there is a chance that they may become good in their field, and we may increase our chances of winning some more medals in the Olympics.

Rituraj
Kota, Rajasthan

Enhancing Social Stability

It is often said: "A healthy mind resides in a healthy body." But in this humdrum 21st century, the students' life is so busy that they

seldom think about their own well being. They are only running in the rat race to fulfill the aspirations of their parents. To overcome this negligence, sports would prove to be the most beneficial thing to help students to be fit physically and mentally. Playing games not only enhances the health status of students but it also envisages a kind of team spirit, which in turn enhances social stability.

So, schools must consider the fact that games are not just wastage of time rather they are such rare treasures that shape the future prospect of a student. So students,

Play games, not only to hit,
But also to be 100% fit.

Vaibhav Gupta
Muzaffarnagar (U.P.)

Make it Compulsory and Provide Financial Assistance

Education should mean a perfect balance between imparting physical and academic education to the child. Considering the fact that the obesity graph for children has been growing drastically since the past few years, the value of sports for children in the school cannot be underrated. Undoubtedly, games and sports help in recreation and are very good for de-stressing, encouraging team building and also teaching them to accept defeat. Sportsmanship and team spirit displayed by the players on the field can be imbibed by the students. Their display of punctuality and self-discipline could be adopted for betterment. Moreover, exercise invigorates the mind and body and helps to keep fit.

Making sports and extracurricular activities mandatory at the school enables kids to realize their own strengths and that is what schools are for. When young kids enter school they are unaware of their strengths and are still developing interest in various things. If extra curricular activities would not be compulsory at school many kids will never get a chance to try them out.

Sports should be made compulsory in schools to introduce a healthy lifestyle to all the school going children. However, there should be more variety of sports and activities like swimming, tennis, track and field, weight lifting (gym), as well as competitive and non-competitive games. Outdoor games are recreational and they ensure that children are exposed to fresh air and exercise, which they may not get at home. The TVs and computers are dragging the students away from any form of physical workout.

Unfortunately, in our country the state of sports is dismal and sportspersons lack proper training and sponsorship. Most of the schools lack the area and the infrastructure for sports. The State governments, school boards and Sports Authorities of India should enact laws to make sports a compulsory subject in schools and also provide financial assistance to schools.

Dr. S.K. Aggarwal
Dean, Academics
Amritsar College of Engineering and Technology

Sports Brings Happiness

I do agree, but schools generally think sports as wastage of time. But in reality, it's no waste; instead it helps children in studies too. It assists them relax their mind which actually make them concentrate better. Sports bring happiness, but most importantly it keeps the young minds fit and healthy. It also helps them find out a new career for themselves.

Sawarnik Kaushal
Patna, Bihar

Part of Learning

Yes, I agree with this proposal. In the age of cut-throat competition, the students do not get much chance to play. Also,

most guardians do not show any interest in playing, they (guardians) stress only on studying. Many students sit all the time before television or computer. But sports are a great part of learning. All work and no play make them dull. If sports are compulsory in schools, then they will get enough opportunity to play with their friends with a free mind.

Anirban Nanda
West Bengal

Be Sporty!

Today, India is witnessing an economic transition. In general, excellence is achieved in every field at the cost of health, due to a sedentary lifestyle. So the

necessity of being healthy and fit should be inculcated right from the school days. In the age of television, Internet and video games school children are becoming more physically inactive which consequently leads to childhood obesity. Childhood obesity is known to be associated with many serious health hazards including diabetes and heart disease in later life.

We cannot deny that sports, particularly outdoor games, play an important role in developing challenging spirits among children. Schools should incorporate outdoor sports activities like swimming, cricket, football etc. Every day, there should be at least one physical training (PT) hour compulsory for every class. Moreover, PT and sports activity should be made mandatory part of the curriculum. There should be a compulsory 100 marks or equivalent grade allotment made for sports activity, just like a regular subject. Children should be encouraged to participate in various sports activities keeping in view their interest and liking after proper counseling.

Most schools in big Indian cities lack playgrounds. The concerned ministry should make the availability of open playing fields mandatory prior to granting recognition to new schools or private educational institutions.

Mehmood G. Sayyad
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Moulding Wet Clay

Children are the future of the country and they are like wet clay—we can mould them into any shape. A child must get all types of education from childhood itself. Generally in schools mental education is given by teaching different subjects. But physical education is also as necessary as mental education because for a developing country like India the youth must be fit enough both physically as well as mentally. So sports should be made compulsory. India is very poor in the field of sports though there are a lot of talented children in every corner. The talented children need some scope to bloom. And this can be possible only by making sports compulsory in school level as it is the only moulding & shaping stage.

Deepesh Kumar Padhan
Odisha

Inner Thirst for Play

Sports are an important part of every student's life. Children should be exposed to information in all the fields of current situation along with formal knowledge. I'm in full support of sports being made compulsory in schools. Being in the curriculum, children will get another reason of their liking to go to school. As every child has a potential, sports being made a part of studies can give them an opportunity to bring out their inner thirst for play. Taking part in sports would rejuvenate both mind and body. These days even the government has introduced an experimental program by the name "Learn with Fun" where 'see and know' and 'do and learn' play important roles.

Vidya C.
Lecturer, Dept of Engineering Physics, DSCE, Bangalore

Fulfilling Dreams

Sports in schools give a good opportunity to sport loving students. There are some students who are not good at studies but excellent in sporting events. It will help them to fulfill their dreams and they could even play for the country. It is useful both for the student and our country as well.

Ningthoujam Chetan
Manipur

PT not Sports Should be Compulsory

Sports should not be made compulsory in schools. Rather the students who are interested in sports should be boosted. Besides the students who are found capable should be encouraged to take up sports. However Physical Training classes should be compulsorily conducted for physical fitness of the students.

Parasar H. Lenka
Dadar (East), Mumbai

Olympic Hopes

Today every one is stressing upon studies. Even a kindergarten student is not being allowed to play the games that he or she likes. Due to this children become addicted to television and computer games, as a result they are becoming obese and are suffering from many diseases from a tender age. Schools are areas for all round development of a child. By implementing sports at the school level we could even get a number of players for the Olympics.

N. Sucharitha
XI Class, JNV, Ongole

Sports is Real Education

Since from the very beginning of civilization we have achieved many milestones of progress through sports. Sport is a form of physical activity that provides enormous opportunity to develop all round personality of a child. It also develops neuromuscular coordination that is vital for learning in a child. Sports bring physiological changes within the human body. Sports also develop several social qualities within a child such as co-operation, honesty, brotherhood, sympathy and cohesiveness. Hence, sports should be a compulsory subject in schools. Without sports the real sense of education cannot be achieved.

Kanu Kisore Sarangi
Raipur, Chattisgarh

Iron Nerves from Sports

School is a platform for holistic development of growing minds. Sports expose the growing minds to a competitive paradigm and help them to adapt to the reality of success and failures as laws of life. Through sports, young boys and girls get opportunity to develop an attitude of cooperation, understanding, the attributes of decision making and experiencing the implications of discipline in real life situations. In this era of stress and strain, sports helps in sublimating negative thoughts and rejuvenating positive aptitudes towards the goal of life. Moreover, iron nerves with an intelligent brain can explore life better from all perspectives.

Dr. Mridusmita Datta
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Sports for Fitness

Sport is something that should be encouraged at the very elementary stage of one's life and school forms an inseparable part of it. Nowadays schools are becoming academic oriented and as a result sports has taken a back seat. Due to this students face health problems and undergo a lot of stress. The list constituting the advantages of sports is endless. Sports should be made a mandatory part of a school's curriculum. Physical activities, competitions, quizzes and other recreational activities related to sports should be included in the routine followed by children in schools.

Rohan Bhardwaj
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Let the Spirit of Games Survive

In India majority of the people think of compulsory things as a burden. A better idea would be to make the availability of sports accessories compulsory to every student. And let the spirit of games survive own its own.

Kostubh Koushik
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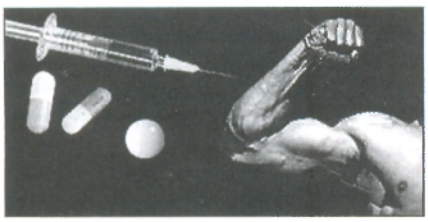
Now write in your thoughts on this topic for inclusion in the forthcoming issues:

"A dedicated science channel is necessary to disseminate authentic scientific information and create scientific temper."

Be brief and be logical! Send in your photo, if you like.

Drugs in Sports

VIVEK SHARMA



Not all athletes play by the rulebook. Many resort to drugs to enhance their performances. Apart from ethical implications of these substances there are serious potential negative health effects too.

IN January this year, an Indian woman weightlifter was banned for life and five others suspended for four years for doping offences. But this was just the most recent incident in a series of shocking doping related acts that have become part and parcel of today's highly competitive sporting arena.

One of the most sensational cases was that of Ben Johnson who was stripped of his 100 m gold medal from the Seoul Olympic Games in 1988 after he admitted to having taken a cocktail of drugs containing Recombinant Growth Hormone (rhGH).

Taking drugs to enhance performances has always been considered a short cut to sporting glory. This is the reason these drugs are also called Performance Enhancing Drugs (PEDs). The "win at all costs" mentality fuels athletes to seek performance-enhancing drugs to gain an advantage over their opponents.

PEDs have been a part of sports activities since as early as 776 B.C. when Olympians used substances such as mushrooms, dried figs and strychnine and later heroin, cocaine and even morphine were used. It was not until the 1980s, however, that the medical community admitted that these substances were effective. Since that time the pervasive use of PED by professional athletes has gained significant media attention.

High levels of PED abuse have been attributed to professional track and field throwers, athletes, body builders, weight lifters and football players since 1960. The outstanding athletic performance of German female swimmers in the 1976 Montreal Olympics brought further public attention to PED athletic abuse.

However, over the years, non-athletes too have come to view PEDs as means to achieving what they believe is a more desirable muscular physique. These beliefs have today filtered down from professional, Olympic and collegiate levels into high schools too. Today, it is exciting the curiosity of the youth.

PED – Historical Facts

- PEDs have been a part of sports activities since as early as 776 B.C. when Olympians used substances, such as mushrooms, dried figs and strychnine. Later heroin, cocaine & morphine were also used.
- The word "doping" was used in the 1860s for horse racing that consisted of opium and narcotics.
- Ancient Greek athletes used a variety of alleged performance enhancing drugs, such as plant extracts and testicular extracts.
- Austrian physiologist Oskar Zoth was the first person to propose injecting athletes with a hormonal substance. In 1896 he described how the use of an "extract" could improve muscular strength.
- Body builders and athletes began using testosterone to increase muscle mass in the 1940s and 1950s.
- In 1974 the International Olympic Committee banned the use of testosterone and its derivatives.
- The exceptional athletic performance of the East German female swimmers in 1976 Montreal Olympics brought further public attention to anabolic steroid use.
- The potential performance enhancing benefits of testosterone precursors were brought to attention in 1998 when major league baseball player Mark Mc Gwire openly admitted to using androsteredione.
- Ben Johnson was stripped of his 100 m gold medal from the Seoul Olympic Games in 1988, he admitted to having taken a cocktail of drugs containing Recombinant Growth Hormone (rhGH).
- rhGH was so popular with athletes that the 1996 Atlanta Olympics was known informally as rhGH games.
- A Chinese swimmer, Yuan Yuan was forced to withdraw from 1998 world championship in Perth, Australia after 13 vials of rhGH were discovered in her suitcase at Sydney airport.
- Jesse Gelsinger died in 1999 as a victim of an immune response to the virus used in a well-publicized gene therapy.
- At the 2000 Olympic games in Sydney a coach from Uzbekistan was caught with a supply of rhGH.
- The sprinter Tim Montgomery (former 100 m world record holder) admitted using rhGH in 2001.
- A physician prescribed rhGH to several players on the Carolina Panthers football team during the team's 2003 championship season.
- More recently, actor Sylvester Stallone was formally convicted of importing 48 vials of rhGH to Australia.

Commonly used PEDs

PED	Potential Benefits	Adverse Effects
Anabolic androgenic steroids	Increases strength & lean body mass, decreases muscle breakdown	Acne, hair on body, breast enlargement in males (gynecomastia), baldness, liver tumors, agitation, psychosis, infertility, ligament injury, precocious puberty in younger adolescents
Steroid hormone precursors	None proven	Increases estrogen levels in boys
Creatine	Increases strength, weight gain, improves performance in sports and anaerobic activities	Kidney toxic, muscle cramps, dehydration
Human growth hormone	Decrease in subcutaneous fat	Heart disease, increased blood pressure, coarse facial features
Diuretics	Weight loss	Dehydration, electrolyte imbalance
Nutritional supplement	No proven effects	
Erythropoetin	Overall improved athletic performance	Hypertension, syndrome related to high viscosity of blood, especially when combined with dehydration
Gene doping	Enhances performance	Gene over expression leading to excessive erythropoesis, hypertension and sudden death

What are PEDs?

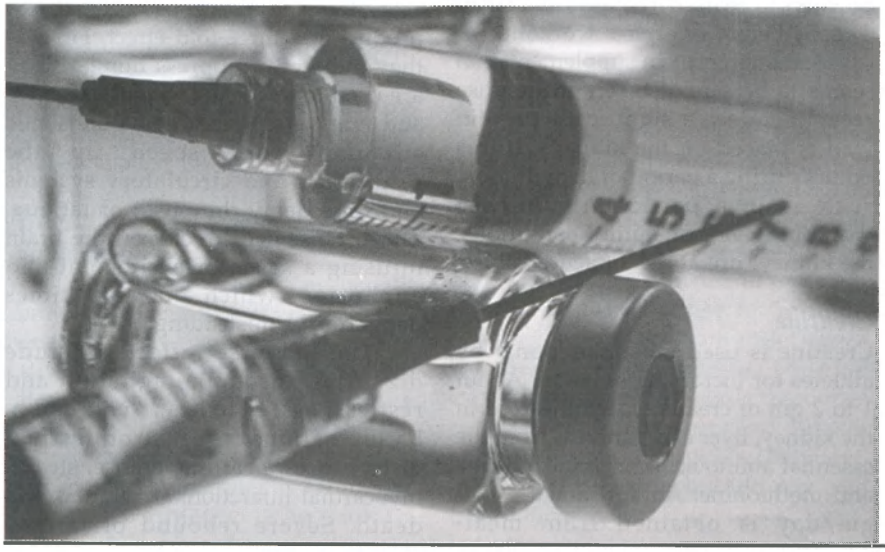
"Any substance taken in non-pharmacological doses specially for the purpose of improving sports performance" could be classified as a PED. This may include prescription medicines, nutritional supplements or illicit substances that individuals use to increase their strength, speed or to control weight or alter body composition.

Anabolic Steroids

Anabolic steroids at supra physiological (greater than normally present in the body) doses increase strength and lean muscle mass when combined with increased calorie intake and exercise. Some athletes "stack" multiple formulations for presumed enhanced efficiency. Steroid "pro-hormones" such as dehydroepiandrosterone (DHEA) and andriostenedione are converted to estradiol more than testosterone and may have many side effects.

Short-term side effects of anabolic steroid use include liver toxicity, endocrine abnormality (gynecomasita, prostatic hypertrophy, hirsutisim, impotence, decreased sperm count, testicular atrophy), blood changes (hyper coagulability, increase in low-density lipo proteins and decreased high density lipo protein cholesterol), musculoskeletal problems (primitive epiphyseal closure, muscle and tendon rupture), oncological disorders (prostatic and breast cancer progression), acne and psychiatric disorders.

Anabolic steroid use is suspected in an athlete who shows a rapid increase in lean mass and strength beyond that expected in normal development. Physical finding includes gynecomastia, testicular shrinkage, jaundice, acne and marked striae.



Erythopoetin (Blood Doping)

Blood doping is a process whereby athletes increase their oxygen carrying capacity by receiving blood transfusion from previously donated blood to increase their haematocrit a few days before the competition and to get more, richer blood than can normally be produced. Since blood carries oxygen to the muscles, more blood means more oxygen and potentially better performances.

There are two known types of blood doping. One uses ordinary transfusions, but that is easy to catch today by looking for foreign proteins on their surfaces. But a more sophisticated method is for an athlete to withdraw some of his or her own blood during training and store it.

The body then builds up replacement blood and, shortly before an event, the extra blood is injected back into the body. This method can sometimes be caught by tests that can tell if a person's haemoglobin is suspiciously high. But athletes using this version of blood doping have been known to inject blood in the morning, race, then have the blood withdrawn later, thereby reducing their chances of being caught by random tests.

List of banned substances and methods

I. List of banned substances

A. Stimulants; B. Narcotics, both natural and synthetic; C. Anabolic agents; D. Diuretics; E. Peptide and glycoprotein hormones and analogs

II. Banned methods

A. Blood doping; B. Pharmacological, chemical or physical manipulation

III. List of substances under restriction

A. Alcohol; B. Marijuana; C. Local anesthetics; D. Corticosteroids; E. Beta-blockers

Another method of increasing oxygen carrying capacity in athletes is by the use of recombinant human erythropoetin (rhuEPO). The ability of rheuEPO to enhance endurance is impressive. Athletes can improve their overall performance by as much as 10% to 15%. Erythropoetin (EPO) is a naturally occurring glycoprotein hormone that regulates red blood cells (RBC) production.

Apart from being illegal, blood doping is dangerous too. Transfusions done at home, for example, can incur the risks of contracting blood-borne diseases and getting sick from bacteria growing in poorly stored blood. Blood doping can also make the blood dangerously thick. Some athletes have even died from efforts to overly enrich their blood. Athletes become particularly prone to myocardial infarction, seizures, stroke and sudden death. When combined with dehydration, athletes are especially at risk for this potentially lethal scenario.

Growth Hormone

Many athletes and bodybuilders believe that the growth hormone (GH) improves athletic performance. However, scientific evidence suggests that, in healthy individuals, GH supplementation does not offer any advantage.

The first purified preparation of hGH dates to 1956 and it was extracted from human cadaver pituitaries. The first clinical use of hGH was reported in 1958 as a treatment for children who have Growth Hormone Deficiency (GHD) to promote linear growth. The clinical use of hGH lasted until 1985, when its use was halted worldwide because of its association with Creutzfeldt-Jakob disease. Since 1985, all GH in clinical use has been obtained by recombinant DNA technology through genetic engineering.

GH also is widely used illegally as an anti-ageing agent and as a performance enhancing substance in athletes. Studies have demonstrated an increase in hemoglobin concentration and improvements in wound healing and ligamentous strength, bone mineral density, strength, cardiac function and quality of life in adult patients who have GHD and are treated with GH.

Despite the lack of evidence supporting significant positive effects of GH as an ergogenic aid, there are reports of the abuse of GH by athletes and bodybuilders for its anabolic properties. Such abuse rests on the belief that GH augments performance in endurance and power sports, is hard to detect and is without major side effects. In addition, it is believed that GH strengthens tendons and ligaments, prevents stress fractures, and speeds the healing process. Among bodybuilders striving to achieve the "ripped look" GH misuse is believed to decrease the subcutaneous fat through a repartitioning effect and to promote hypertrophy of their muscle fibers.

Nutrition Supplements

Protein supplements are often used by athletes with the hope of adding muscle or repairing muscle damage from workouts. They are sold in powders to be used in shakes and taken directly before or after a workout.

Although protein supplementation seems to be safe, if taken at the dose recommended, a significant protein load is placed on the kidneys. If this occurs during a period of dehydration, such as in a particularly intense workout in hot or humid conditions, the kidneys are at risk of acute failure.

Creatine

Creatine is used most commonly by athletes for increasing strength. About 1 to 2 gm of creatine is synthesized in the kidney, liver and pancreas from the essential amino acids arginine, glycine and methionine. An additional 1 to 2 gm/day is obtained from meat-containing diets. The remaining creatine is concentrated to creatinine and cleared by the kidneys. Creatine is sold in powder form or liquid form in recommended dosages sometimes greater than 10 gm/day. Taking doses greater than 2 gm/day is unnecessary and potentially harmful to the kidneys. Other reported side effects include weight gain, nausea and muscle cramping.

Narcotics & Analgesics

Narcotics and analgesics include morphine, codeine and penthidine. These are powerful painkillers producing a sense of euphoria and help players perform beyond their normal threshold of pain. As a result the player could seriously injure himself since he fails to recognize small injuries because of reduced pain. An overdose may even lead to stupor or coma. Beta blockers are drugs that reduce the heart rate. Archers and sharpshooters resort to these drugs to steady their hands. But it may lead to sleep disturbances and in extreme circumstances could also lead to a cardiac arrest.

Stimulants

Stimulants are even being used by high school and college athletes today. Common stimulants include caffeine, ephedrine, pseudoephedrine, neosynephrine, amphetamines and metamphetamines.

Stimulants can be found in coffee, colas, energy drinks, cough and cold medications, muscle building or weight loss supplements, attention deficit hyperactivity disorder medications and diet pills. Stimulants act on the central nervous system (CNS) producing a three-fold effect. First, as they indirectly suppress hunger, they are used to lower the weight of boxers and wrestlers. Second, as a metabolic stimulant they speed up the respiratory and circulatory systems and thus delay the onset of fatigue. Third, these act directly on the brain infusing a sense of excitement and euphoria, which is at times dangerously misleading.

The adverse effects include dizziness, insomnia, agitation and restlessness, anxiety, confusion, hallucinations, gastrointestinal disturbances, heat intolerance, stroke, myocardial infarction, arrythmias and death. Severe rebound of fatigue

The lure of glory makes sportspersons and their medicos resort to all sorts of tricks. For instance, a sportsperson would take a substance naturally occurring in the body such as human growth hormone, and if it is detected claim that the sportsperson happens to have a higher hormone-level.

and depression occurs after discontinuation.

Glycerol

Glycerol is an osmotically active molecule that is used to optimize hydration status for the purpose of improving performance in warm conditions. It may be useful for athletes who undertake multiple exercise sessions daily (e.g. football players, all day tournaments in other team and individual sports).

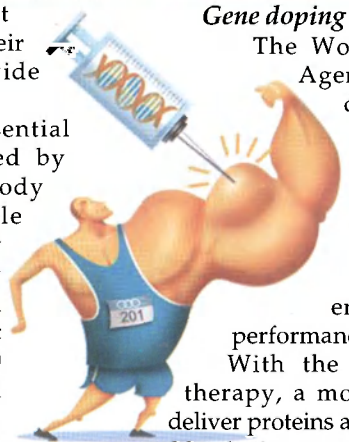
Glycerol has been shown to be safe in doses upto 5 gm/kg body weight. But when used for hyper-hydration before exercise it has had adverse effects of gastro upset, headache and blurred vision.

Vitamin, Mineral & Iron Supplements

As a general rule, there is no benefit from supplementation of vitamins and minerals above the recommended daily amounts. With an adequately balanced diet athletes without any medical condition that predisposes to vitamin deficiency will not enhance performance by supplemental intake. However, athletes who follow restrictive diets may benefit from supplementation if their diet does not provide recommended amounts.

Chromium is an essential trace element that is used by athletes for modifying body composition (e.g. muscle building, decreasing body fat). It is most commonly ingested as chromium picolinate in quantities that provide approximately 100 times the recommended amount.

Iron supplement is used commonly by athletes for enhancement, a practice that can be helpful or harmful. In the presence of iron deficiency anemia, iron supplementation is clearly beneficial for performance. However, the diagnosis can be difficult to establish in athletes. In response to training, haemoglobin concentration decreases transiently as the plasma volume expands to a greater degree than does red cell mass, the so-called 'sports anaemia'. Ferritin levels also decrease, but this usually does not indicate true iron deficiency.



Gene doping

The World Anti-Doping Agency (WADA) defines gene doping as "the non therapeutic use of genes, genetic elements and/or cells that have the capacity to enhance athletic performance".

With the advent of gene therapy, a more direct way to deliver proteins and hormones to an athlete's tissues and organs became reality. A substance that can alter the basic genetic expression of DNA such that muscles grow larger, contract more forcefully, and recover more quickly than non-doped muscles and cannot be detected by anti-doping laboratories would be ideal to gain a competition advantage. It can be of two types.

- **In vivo gene doping:** The delivery of the new gene into an athlete can be through biologic, physical or chemical methods. Viruses can be modified to biologically insert the artificial gene into cells in a specific organ or target

Drug Testing Kit

The "win at all costs" mentality fuels athletes to seek drugs to gain an advantage over their opponents.

This is the reason these drugs are also called Performance Enhancing Drugs (PEDs).

tissue or into cells throughout the competitor's body.

- **Ex vivo doping:** The technique of exogenous gene doping includes gene transfer to cells in culture first, then implantation of the tissue into the recipient. Once implanted into the athlete's cell, the new genes express hormones or biochemicals that enhance performance of the athlete during competitions.

Catching the Culprit

The lure of glory makes sportspersons and their medicos resort to all sorts of tricks. For instance, a sportsperson would take a substance naturally occurring in the body such as human growth hormone, and if it is detected claim that the sportsperson happens to have a higher hormone level. However, testing rules now specify the highest permissible levels of such molecules as well.

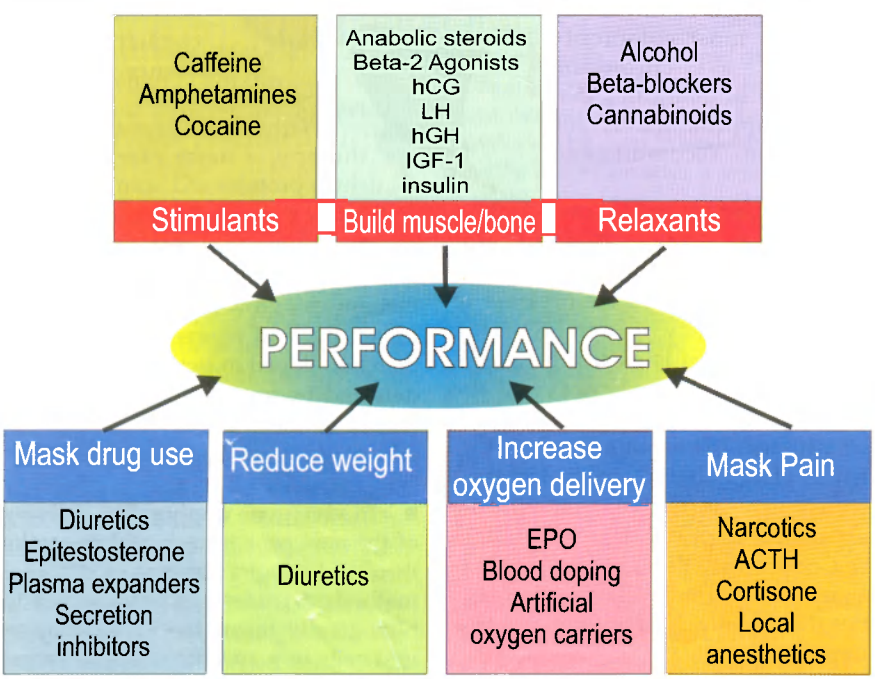
Another method is by reducing the excretion of the tested substances in urine. Earlier weightlifters would take probenecid, used in gout, to reduce the excretion of anabolic steroids in urine. Suddenly musclemen increasingly started claiming to be gout sufferers until the testers got wise and banned probenecid as well. Catching athletes indulging in doping, therefore, has always been a cops and robbers game.

The first step in a doping control test is getting an authentic urine sample from the correct person and getting it sealed. Athletes selected for a test identify themselves before they urinate in a cup, under direct observation of an official of the same gender. Next the urine is poured into a pair of bottles, A & B, labelled only with numbers (eg. 23652A and 23652B) and the bottles are sealed. Only the sport organization – not even the laboratory – knows which number corresponds to which athlete.

Testing urine is better than testing blood for most prohibited substances (small molecule, molecular weight less than 800 atomic mass units). Urine collection is non invasive and yields a large volume of sample, with higher drug concentration than in blood and with far fewer cells and proteins to complicate extraction.

There are several detection techniques performed in laboratories to test for banned drugs. These are based on immunological or radioimmunological methods, separative methods such as gas chromatography and liquid chromatography and methods associating two techniques, such as chromatography/mass spectrometry, or chromatography/atomic emission detection.

Undoubtedly, athletes always have striven, and will continue to strive, to improve their performance through means such as physical training, improved nutrition, and skills training. But there are some among them that resort to short cuts and take recourse to performance-enhancing substances. Apart from ethical implications of these substances there are serious potential negative health effects too. This has to be realized by sportspersons at all levels—right from international levels down to the school level too.



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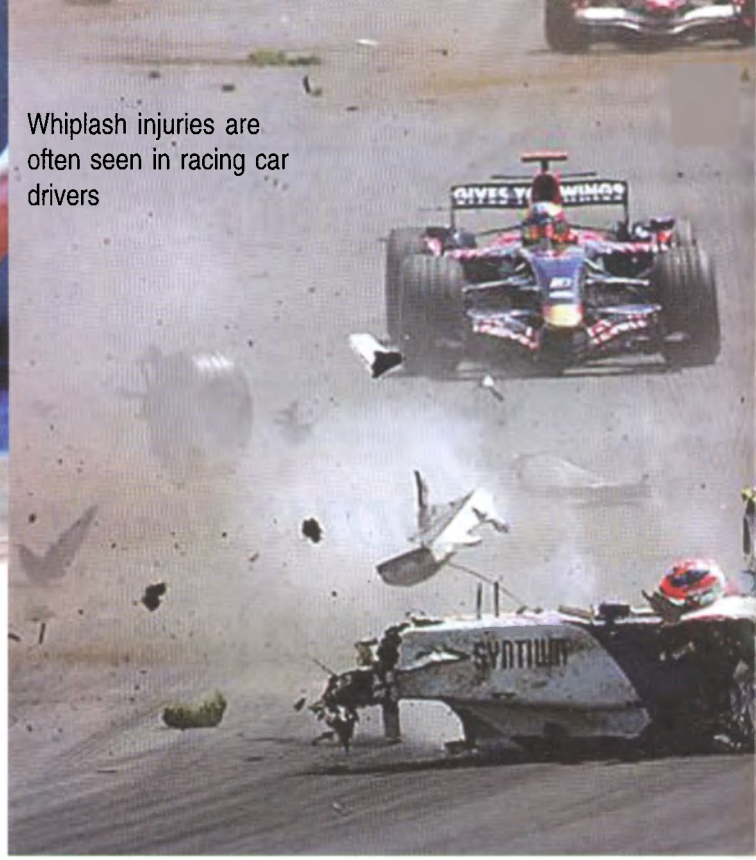
Agony Behind the Ecstasy

SUKANYA DATTA

It is through a disciplined regimen of exercise and by building up their bodies to stretch beyond limits and regular practice that sportspersons are able to make their presence felt at the highest level of sporting events. Yet, sports injuries are very much part of the game and could strike any sportsperson.

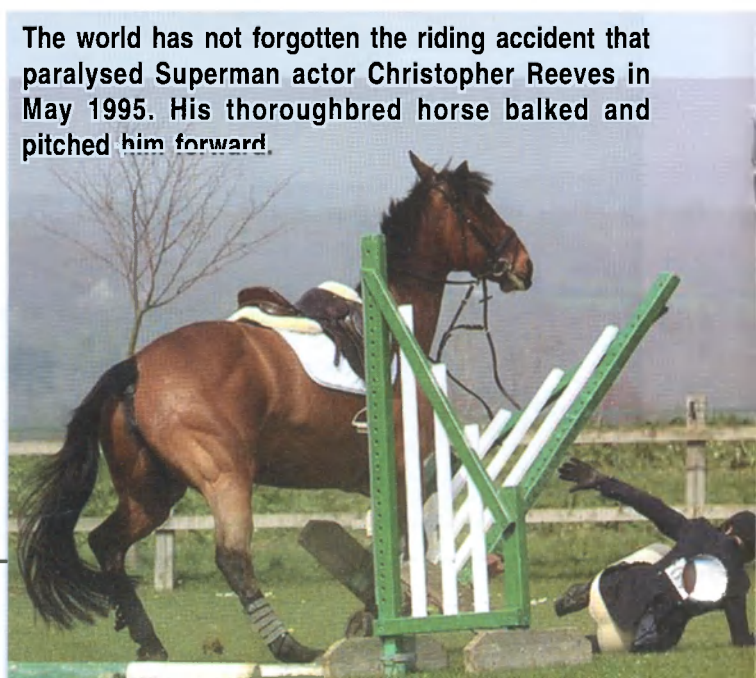
WE applaud our sportsmen as we see them smiling ecstatically on the podium, draped in the national colours. We get misty-eyed as we see them kiss their hard-earned medal as the national anthem plays. What we do not see are the sacrifices the sportsmen made on the way to the podium. We do not see the gruelling training schedules, the blistered palms from tightly gripping bat or racquet handles, the mauled muscles, the torn tendons and the excessive wear and tear leading to battered bodies.

One does not get to become a champion without undergoing regular and rigorous training over an extended period of time. Athletes, in particular, begin training at a tender young age when they are most supple. Nadia Elena Comaneci, the first gymnast ever to be awarded a perfect score of 10 in an Olympic gymnastic event (aged 14) was five years old when she began training. Gymnast Dimitrios Loundras, Bronze medallist at the 1896 Summer Olympics in Athens, was just over 10 years old at the time. He remains the youngest Olympic medallist till date. These are just two examples from innumerable others in the arena of sports.

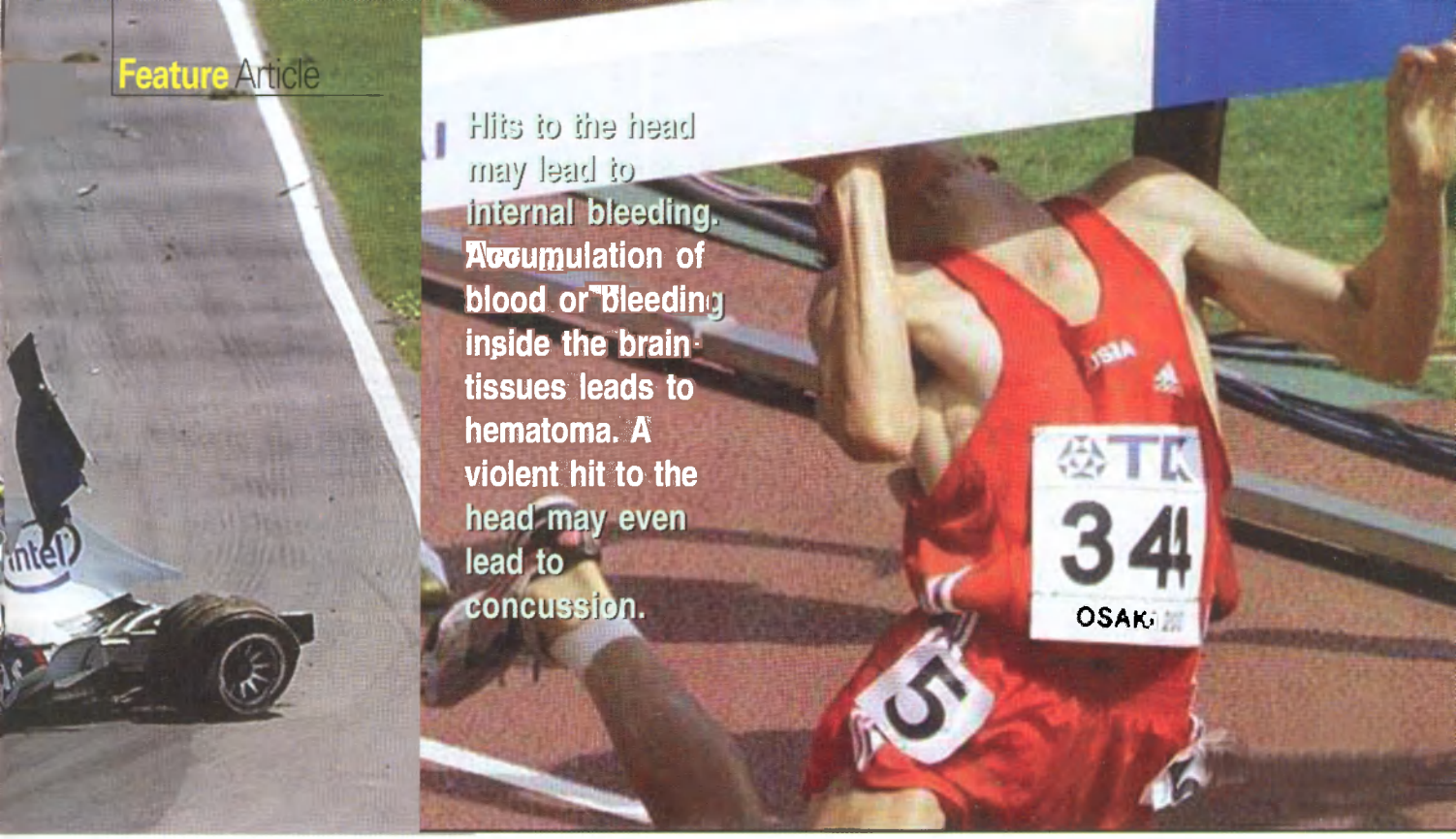


Whiplash injuries are often seen in racing car drivers

Of course, if one trains rigorously over extended periods there is always the chance that overuse and strain-related injuries may surface. In addition, contact sports increase the chances of accident-related injuries, while sports that involve overuse of a particular part of the body often lead to chronic injuries. Accidents, poor training practices, improper equipment, lack of conditioning, or insufficient warm-up and stretching can all lead to injuries sustained while indulging in one's favourite sport.



The world has not forgotten the riding accident that paralysed Superman actor Christopher Reeves in May 1995. His thoroughbred horse balked and pitched him forward.


Hits to the head may lead to internal bleeding. Accumulation of blood or bleeding inside the brain tissues leads to hematoma. A violent hit to the head may even lead to concussion.
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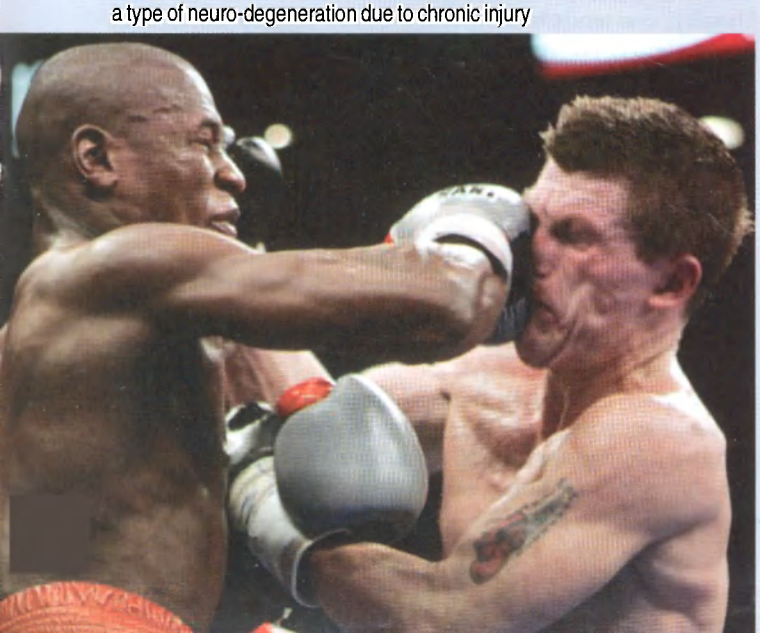
OSAK

Injury and Sports: Going Hand in Hand

Injury-rates, expressed as injuries experienced per hour of activity, are indicators of just how injury-prone a particular sport is. Rates above 5 injuries per 1000 hours of activity are considered high. According to reports, sports such as rugby and lacrosse result in about 30 injuries per 1000 hours of activity. About a third of all injuries suffered by rugby players are head and neck injuries; 59% of which are suffered while tackling or being tackled. Of course, injuries while playing rugby and lacrosse are often the result of impacts with other players – or with their equipment. Basketball and squash result in 14 injuries per 1000 hours. Running scores about 11 injuries per 1000 hours. A research paper in *Nature* on spinal injuries reports that injuries sustained as a result of horse riding are common with serious injuries to the nervous system being the most dangerous.

Being "punch-drunk" is an apt, if colloquial description of Dementia pugilistica, a type of neuro-degeneration due to chronic injury



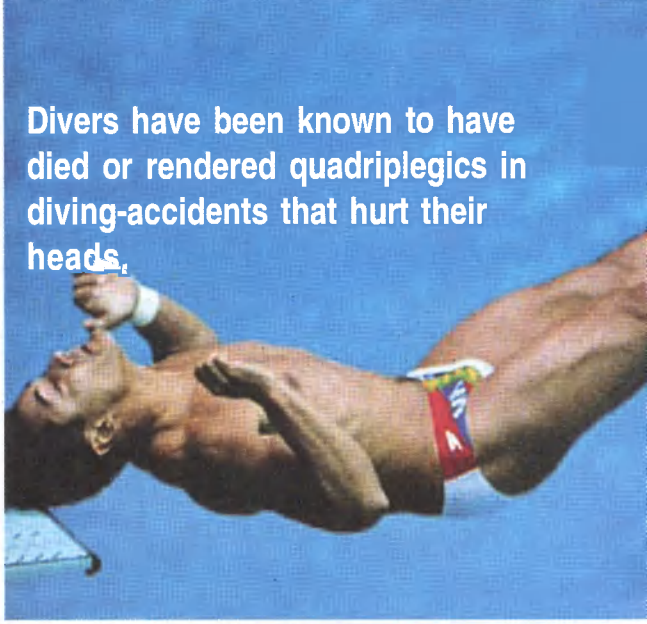
There also appear to be some differences between the injuries suffered by men and women participating in the same activity. A recent study in the US found that when it came to weightlifting, women were more likely to injure their feet and legs, while men's injuries were more common in the trunk and hands; men had more sprains (overstretched ligaments) and strains (overstretched tendon/muscle), and women had more fractures (broken bones).

The risk factors that lead to injury are usually classified as: Extrinsic (outside the body) and Intrinsic (pertaining to the body).

It is important, however, to differentiate between Impact injuries and Overuse injuries when talking about sports-related injuries.

Impact or traumatic injuries happen when there are collisions. Impact-related injury is called acute injury. Fractured bones are acute injuries. A cricket ball hitting the batsman may result in cracked ribs and a ricocheting squash ball may seriously hurt the eye on contact. In alpine skiing, collisions account for 90% of all fatalities; trees are the most commonly struck objects (~ 60% of all fatalities) and collisions with other persons account for ~10% of the fatalities. Weightlifters often injure themselves by dropping weights on themselves or crushing a body part between weights.

Accidents usually happen so suddenly and so swiftly that there is little a player can do to prevent them. For example, the racing car may spin out of control, hit a barrier, overturn and burst into flames. Brazilian racing car driver Ayrton Senna da Silva, one of the greatest drivers in the history of Formula One, died after sustaining severe injuries to the head in a crash while leading the 1994 San Marino Grand Prix. Tragically, the same event had also seen the death of his friend Roland Ratzenberger from skull fracture in another crash.



Divers have been known to have died or rendered quadriplegics in diving-accidents that hurt their heads.

Head injuries, if severe enough, can kill instantly. In 1998, promising cricketer Raman Lamba died after being hit on the head with a cricket ball.

Signs of acute injury are:

- Sudden, severe pain accompanied by swelling
- Not being able to place weight on the affected body part
- Feeling of tenderness in affected area and/or inability to move a joint
- A bone that is visibly out of place; maybe even protruding out of the skin.

Overuse injuries occur over time, and are a result of identifiable reasons, and so can often be prevented. The injuries that a person may suffer while running, cycling, swimming, stair climbing, and walking are not due to impact, but usually, because of overuse.

Injury that manifests usually as pain over time is most likely to be overuse injury and is called chronic injury. Being "punch-drunk" an apt, if colloquial description of Dementia pugilistica, which is a type of neuro-degeneration (seen in boxers or athletes who suffer concussions), is an example of chronic injury. Archery is a non-contact sport that involves simple graceful movements, not violent impact (apart from the minimal risk of a stray arrow hitting someone). Yet, the archer needs to maintain a constant draw on the bowstring, putting the rotator cuff muscles under constant strain. The action of holding the string back puts additional stress on these muscles, leading to the potential for chronic strains. An archer also needs to keep the aim steady and so the shoulder muscles tend to get stressed.

Signs of chronic injury are:

- Pain when playing/exercising
- Swelling

Vulnerable Areas

Usually, one tends to associate the back and the limbs with sports-injury. However, there is hardly a part of the body that is not vulnerable to injury if care is not exercised. Front teeth, for example, are particularly vulnerable to impact injuries in contact sports such as rugby, football, hockey and boxing.

Head and Neck Injuries

Head injuries, if severe enough, can kill instantly. In 1998, promising cricketer Raman Lamba died after being hit on the head with a cricket ball. In 2009, veteran cricket umpire Alcwyn Jenkins died after being hit on the head by a ball as he oversaw a match.

Injuries that "snap the neck" can have equally tragic results. The world has not forgotten the riding accident that paralysed Superman actor Christopher Reeves in May 1995. His thoroughbred horse balked and pitched him forward.

Back injuries usually dog football/basketball/ice hockey players, gymnasts, figure skaters and weight lifters

Reeves landed head first, fracturing the uppermost vertebrae in his spine. He was instantly paralyzed from the neck down. Only prompt medical attention saved his life. During the Seoul games in September 1988, Greg Louganis cracked his head on the diving board as he attempted a dive. He was lucky not because he came back to win two gold medals the next day but because he got off relatively lightly. Divers have been known to have died or rendered quadriplegics in diving-accidents that hurt their heads.

Hits to the head may lead to internal bleeding. Accumulation of blood or bleeding inside the brain tissues leads to hematoma. A violent hit to the head may even lead to concussion. If this injury is recurrent or severe, brain damage can occur. If the head experiences an abrupt jerking motion, a whiplash injury may result. Whiplash injuries are often seen in racing car drivers, divers, practitioners of martial arts and, sometimes, in football/rugby players.

Back Injuries

Injuries to the back usually happen when the back muscles are twisted or overexerted. Lifting or bending incorrectly leads to damage to the back. Traumatic fractures, stress fractures, sprains, contusions, and strains are all conditions that characterise back injuries. These injuries usually dog football/basketball/ice hockey players, gymnasts, figure skaters and weight lifters

Arm, Hand and Wrist Injuries

Dislocations, fractures, and sprains result because of a fall that forces the fingers or hand backward. These may also be caused by a direct hit. Such injuries are often seen in contact sports, for example, lacrosse, football, and hockey. Cricketers may suffer impact injuries, such as broken fingers when taking a catch.

Tennis elbow is a painful condition that got its name from the fact that many tennis players were affected by it. It is caused by overuse/repetitive strain as a result of repeated extension (bending back) of the wrist against resistance and may affect non-tennis players too. A similar condition is called Golfer's elbow. Badminton and squash players suffer from both the syndromes although the terms do not include them!

Archers experience "String Slap" when the bowstring is released and it slaps along the forearm on the way back. String slaps cause swelling and bruising because of bleeding under the skin. The constant strain placed on the tendons during archery can lead to inflammation specifically at the wrists, elbows, and shoulders.

Leg, Knee and Feet Injuries

Fractures account for one quarter of all football injuries requiring hospitalization and are almost always impact injuries. However, stress fracture of the lower leg, as seen in runners, is generally considered an overuse injury. Shin splints (pain along the tibia or shin bone, the large bone in the front of the lower leg) are common to those who run marathons.

Running, gymnastics, and volleyball all involve repetitive stress of the foot striking a hard surface. Running creates forces 2-3 times a person's body weight on the lower limbs. This causes trauma and muscle fatigue; increasing the risk of stress fractures.

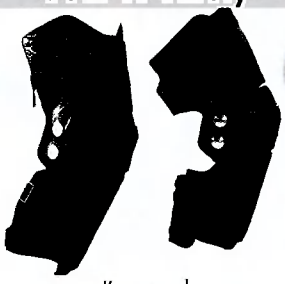
Achilles tendon injury results from a stretch, tear, or irritation to the tendon connecting the calf muscle to the back of the heel. It is a common injury among middle and long distance runners. Partial or complete Achilles tendon ruptures are seen in sprinters and those into racquet sports. Fast bowlers are always at risk of muscle strains particularly in the quadriceps and hamstrings. They are also prone to ankle and knee injuries from their run up.

Most sports injuries involving the feet include stress fractures, ligament strains, and heel bruises. The feet support the body's weight and have to repeatedly absorb a lot of

Gear to safety

Boxing helmet

Elbow guard


Knee guard

Weight lifting gloves

Finger support for basket ball

force leading to chronic injuries. Athletes who injure their feet often describe tingling, burning, numbness or pain under the heel. Ankle injuries are usually caused by stretching and tearing of the ligaments. Practitioners of martial arts are prone to ankle injuries. The toes seem to be insignificant body parts but Turf toe or pain at the base of the big toe can bring an athlete down. The injury usually results from excessive upward bending of the big toe joint and is usually the result of practicing on a hard surface. Sudden use of a muscle as when executing an overhead smash, in tennis or badminton, may result in the disruption of muscle fibres and lead to pain, swelling, and even loss of function for a while.

Cricket helmet and cycling helmet

The knee is another vulnerable area. Pain in the knees is connected to overuse when repetitive small stresses are not allowed to recover adequately. Knees may suffer sprains, strains, damage to cartilage and of course, damage due to overuse. Any activity that calls for stopping, with quick changes of direction, puts the knees under pressure. Footballers therefore often suffer knee pain. In squash, for example, frequent twisting and lunging is required which places a lot of stress on the knees. Sudden twisting movement of the knee while playing badminton or tennis sometimes results in the tear of the meniscus. About one third of all alpine ski injuries affect the knee joint. Pain or tenderness close to or under the kneecap at the front or side of the knee is called Runner's knee! It is clear from the name that long distance runners suffer chronic knee pain. Cyclists do too.

Groin Injury

The groin area involves the musculo-skeletal, gastro-intestinal, genito-urinary systems, and neuro-vascular structures. Pain in this area is called Athletic pubalgia, or sportsman's /sports hernia. Soccer and Ice hockey players often experience debilitating groin pain. Gilmore's groin hernia (a sort of sports hernia) or groin disruption in athletes was recognized as a medical condition by Jerry Gilmore in 1980 and he developed a surgical procedure to treat it.

Treating Sports Injuries—The RICE Way

Rest, Ice, Compression, and Elevation (RICE method) is used to treat most sports-related injuries. In addition, non-steroidal anti-inflammatory drugs (NSAIDs) such as Aspirin, Ibuprofen, and Ketoprofen are prescribed to reduce swelling and pain. The injured limb is often immobilized using slings, splints or casts. Sometimes, surgery may be needed to take care of torn tendons/ligaments or broken bones.

Rehabilitation is an important part of recovery. It involves exercises that slowly encourage the injured area to get back to normal. Initially the injured limb is coaxed into exercising gently and passing through a range of motions. Later, weights may be used to strengthen the injured area. Care must be taken when scar tissue (normal healing process) starts to form.

Prevention Strategies

It is almost impossible to totally prevent all sports-related injuries. However, it is definitely possible to reduce the number of injuries and to minimise the damage caused.

Most contact games have evolved their own safety gear that is designed to protect. It is advisable to wear helmets, protective pads on knees, elbows etc.

Warming up before the actual game slowly acclimatises the muscles and tendons to the impending stress and strain. It is equally important to cool down after the game.

Apart from respecting the rules of the game, it is also important not to overdo it. Sportsmen should realize their body's limits and gradually build up exercise level allowing the body adequate time to recuperate. It is also advisable not to play when injured/recovering.

Sports medicine is a sophisticated and specialized branch of medicine and most teams/individual players, irrespective of the sports, have their own medical advisors. On a lighter note, it can be said that perhaps chess is the only sports activity that is not plagued by injuries since it is largely contemplative in nature. Except for the odd broken nail once in a while and what is jocularly reported as temporary blindness leading to non-observance of the opponent's winning move, the world of chess appears to be happily injury-free.

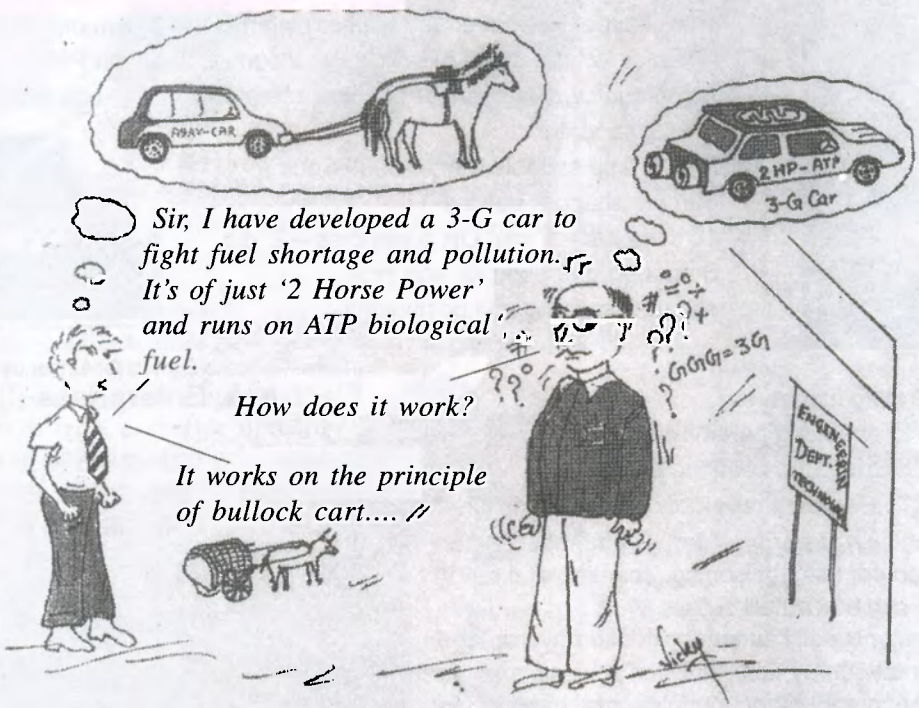
Of course, the sports fan must be prepared to face at least one virtual injury from time to time—a broken heart! It happens when the side supported, faces defeat. The way to prevent this is to cultivate sportsman's spirit and learn to accept defeat with grace, not rage.

Dr. Sukanya Datta, Scientist NISCAIR, posted to Director General's Technical Cell, CSIR-HQ. Email: sukanya@csir.res.in

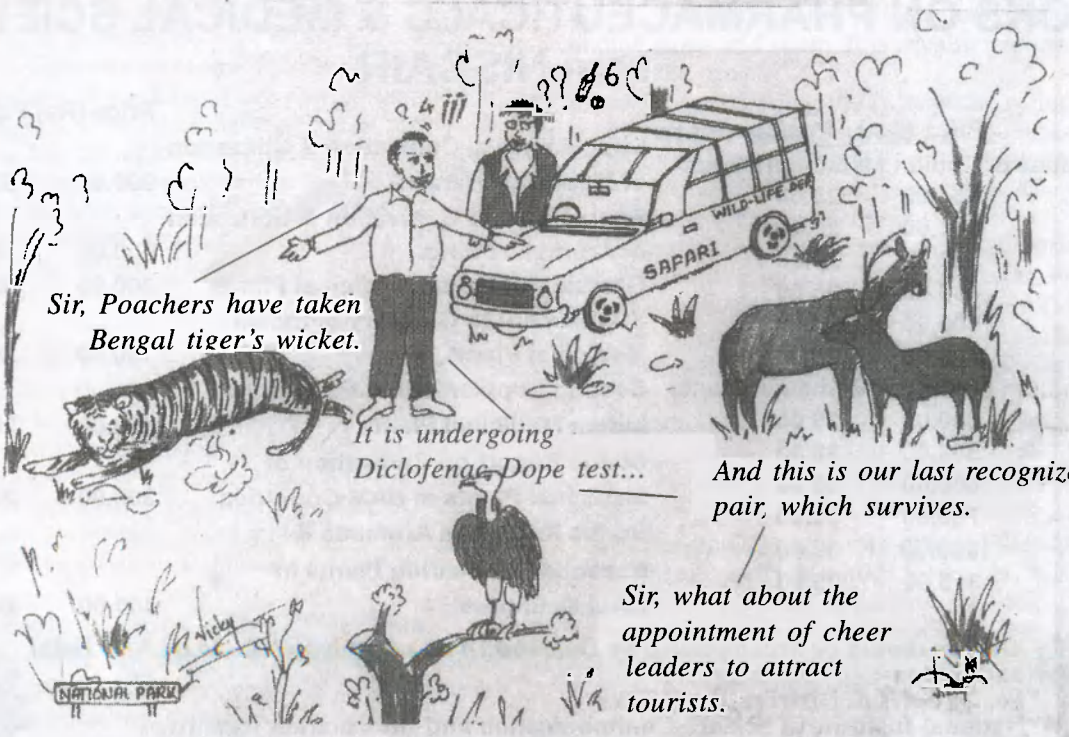
CARTOONS by

SHRI VIKRAM SINGH

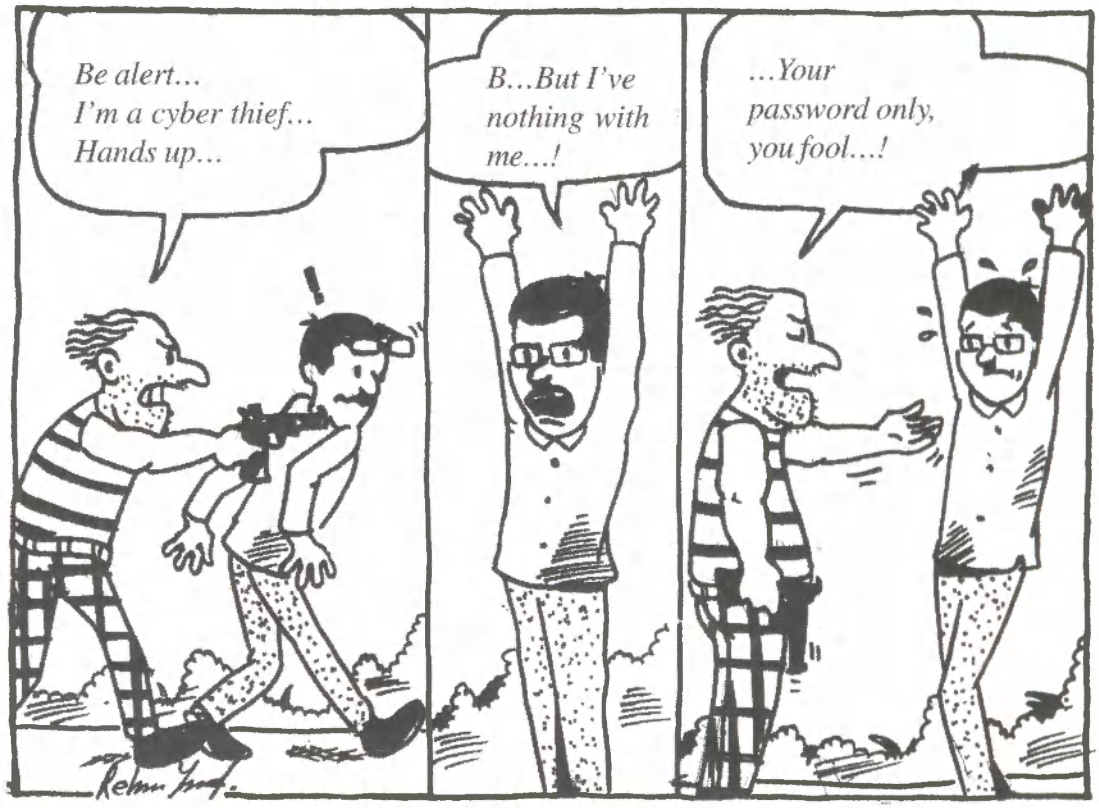
S/o Shri Hari Singh Saini, HNo. 462/21, Sukhpura, Gohana Road, Rohtak 124001


2 HP - ATP
3-G Car
Sir, I have developed a 3-G car to fight fuel shortage and pollution. It's of just '2 Horse Power' and runs on ATP biological fuel.
How does it work?
It works on the principle of bullock cart....
ENGINEERING DEPT.

CRICKET MANIA

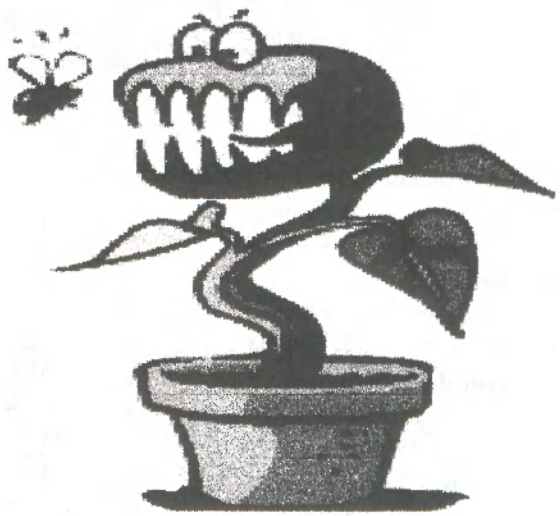

WILD-LIFE DEP.
SAFARI
Sir, Poachers have taken Bengal tiger's wicket.
It is undergoing Diclofenac Dope test...
And this is our last recognized pair, which survives.
Sir, what about the appointment of cheer leaders to attract tourists.
NATIONAL PARK

CARTOON by
SHRI REHAN YUSUF
Aliya Hardware, City Post Office, Motihari 845401 (E. Champaran), Bihar



CARTOON by
SHRI RISHBH RAI SRIVASTAVA
2-B, SFS DDA Flats, Skylock Apartments, Delhi 110096

Natural Insect Killer



Venus Fly Trap

- No Pollution
- Non toxic
- CFC Free

SCIENCE ANALOGY

PRABIN KUMAR SHARMA

Select the correct alternative that has the same relationship as the given pair.

1. **Sphygmomanometer: Blood Pressure:: Odometer : ?**
   a. Temperature b. Wind
   c. Speed d. Strains
2. **Angle: Radians:: Conductivity : ?**
   a. Candela b. Mho
   c. Ampere d. Pascal
3. **Sheep: Flock:: Bees : ?**
   a. Swarm b. Shoal
   c. Horde d. Herd
4. **Butterfly: Caterpillar:: Horse : ?**
   a. Larva b. Cub
   c. Lamb d. Pony
5. **Stag: Doe:: Drone : ?**
   a. Bee b. Mare
   c. Bitch d. Lioness
6. **Lizard: Reptile:: Whale : ?**
   a. Pisces b. Mammals
   c. Aves d. Rodents
7. **Ethnology: Human race:: Concology : ?**
   a. Skull b. Classification
   c. Shells d. Algae
8. **Influenza: Virus:: Typhoid : ?**
   a. Bacillus b. Parasite
   c. Protozoa d. Bacteria
9. **Chromites: Chromium:: Ilmenite : ?**
   a. Limestone b. Cobalt
   c. Manganese d. Titanium
10. **Planet: Orbit:: Projectile : ?**
    a. Trajectory b. Track
    c. Milky Way d. Path
11. **Oxygen: Burn:: Carbon dioxide : ?**
    a. Isolate b. Foam
    c. Extinguish d. Explode
12. **Eye: Myopia:: Teeth : ?**
    A. Pyorrhea b. Cataract
    c. Trachoma d. Eczema
13. **Glucose: Carbohydrates:: Soybeans : ?**
    a. Proteins b. Vitamins
    c. Minerals d. Legume
14. **Wool: Sheep:: Mohair : ?**
    a. Cat b. Goat
    c. Cow d. Camel
15. **Heart: Pericardium:: Brain : ?**
    a. Bones b. Head
    c. Skull d. Cranium
16. **Cells: Tissues:: Atoms : ?**
    a. Elements b. Molecules
    c. Electrons d. Organs
17. **Roentgen: X-Rays:: Becquerel : ?**
    a. Uranium b. Radioactivity
    c. Fission d. Superconductivity
18. **Winter: Hibernation:: Summer : ?**
    a. Survival b. Activation
    c. Aestivation d. Cache
19. **Birds: Aviary:: Bees : ?**
    a. Aquarium b. Hive
    c. Beewary d. Apiary
20. **Bollworm: Cotton:: Ghundibug : ?**
    a. Wheat b. Rice
    c. Millet d. Tomato

ANSWERS:

1.c : 1st is instrument to measure 2nd
2.b : 2nd is unit of 1st
3.a : a group of 1st is called 2nd
4.d : 2nd is young one of 1st
5.a : 1st is male. 2nd is female
6.b : 1st belongs to class of 2nd
7.c : 1st is the study of 2nd
8.d : 1st is a disease caused by 2nd
9.d : 1st is a mineral of 2nd
10.a : 2nd is path traced by 1st
11.c : 1st helps in 2nd
12.a : 2nd is a disease of 1st
13.a : 1st is rich in 2nd
14.b : 1st is a fibre obtained from 2nd
15.d : 2nd is protective covering for 1st
16.b : 1st constitutes 2nd
17.b : 1st discovered 2nd
18.c : 1st sleep of animals is called 2nd
19.d : 2nd denotes the place where 1st is kept.
20.a : 1st is a pest that damages 2nd

Contributed by Prabin Kumar Sharma, Dilawarganj, Purabpalli, Kishanganj, Bihar 855107;
Email : prabinkr.s@gmail.com

REMOTE SENSING

NEERAJ KUMAR

1. **Name of the branch of science that involves collection and interpretation of information about a target without physical contact?**
   a. Remote Sensing b. Quantum Mechanics
   c. Astrophysics d. Nuclear Physics
2. **Who coined the word Remote Sensing in 1960?**
   a. Sir Isaac Newton b. Fischer
   c. Henry Ford d. Copernicus
3. **How many platforms are used in remote sensing technology (ground based, air borne and space borne)?**
   a. 3 b. 7
   c. 8 d. 4
4. **Satellites that are synchronous with earth orbit are known as?**
   a. Military Satellites
   b. Geostationary Satellites
   c. Sun synchronous Satellites
   d. Communication Satellites
5. **Satellites that move from the North Pole to South Pole are known as?**
   a. Polar Satellites b. Navigator Satellites
   c. Scientific Satellites d. Weather Satellites
6. **Sensors that sense the natural radiation are called:**
   a. Sagacity Sensors b. Erudition Sensors
   c. Passive Sensors d. Sophistication Sensors
7. **Sensors that produce their own radiation are known as?**
   a. Convolution Sensors
   b. Intricacy Sensors
   c. Multifariousness Sensors
   d. Active Sensors
8. **The art of map making is called cartography and the people who make maps are known as?**
   a. Boffin b. Virtuoso
   c. Cartographers d. Maven
9. **How many lines are there between the equator and each pole?**
   a. 91 b. 230
   c. 92 d. 89
10. **What is the name of the world's first artificial satellite?**
    a. Sputnik 1 b. TIROS
    c. METSAT d. GOES
11. **A change in the observed frequency of electromagnetic or other waves caused by relative motion between the source and the observer is known as.....**
    a. Doppler effect b. Gravitational effect
    c. Radiating effect d. Reflection
12. **Cartographers use different colours to represent the various types of information on the map, this technique is known as...?**
    a. Fake colours b. Phony colours
    c. False colour composite d. Bogus system
13. **We find a place on the map with the help of a network of imaginary lines known as?**
    a. Grid b. Network
    c. System d. Link
14. **Representation of a 100-meter length by 10 centimeters on the map is known as?**
    a. Trim b. Scaling down
    c. Dapper d. Magnitude
15. **The science of measuring quantities or data, transmitting the data to a distant station and there interpreting, indicating or recording the data is known as?**
    a. Telemetry b. Photometry
    c. Radiometry d. Optometry
16. **Regular repetition of tonal variation on an image or photograph is known as?**
    a. Pattern b. Outline
    c. Silhouette d. Archetype
17. **A general term used to denote an increase in signal power in transmission from one point to another...**
    a. Acquisition b. Procurement
    c. Gain d. Ruling
18. **At which height do the satellites move in space?**
    a. 36000 km b. 50000 km
    c. 45000 km d. 60000 km
19. **For radar image, this term represents the distance measured along a line between the antenna and the target.**
    a. Slant Range b. Assortment
    c. Gamut d. Gradation
20. **A gradual reduction in density of parts of a photographic image caused by the blocking of some rays entering the lens is known as?**
    a. Vignetting b. Contamination
    c. Detoxification d. Dirt

ANSWERS:

1. a	2. b	3. a	4. b	5. a	6. c	7. d	8. c
9. d	10. a	11. a	12. c	13. a	14. b	15. a	16. a
17. c	18. a	19. a	20. a				

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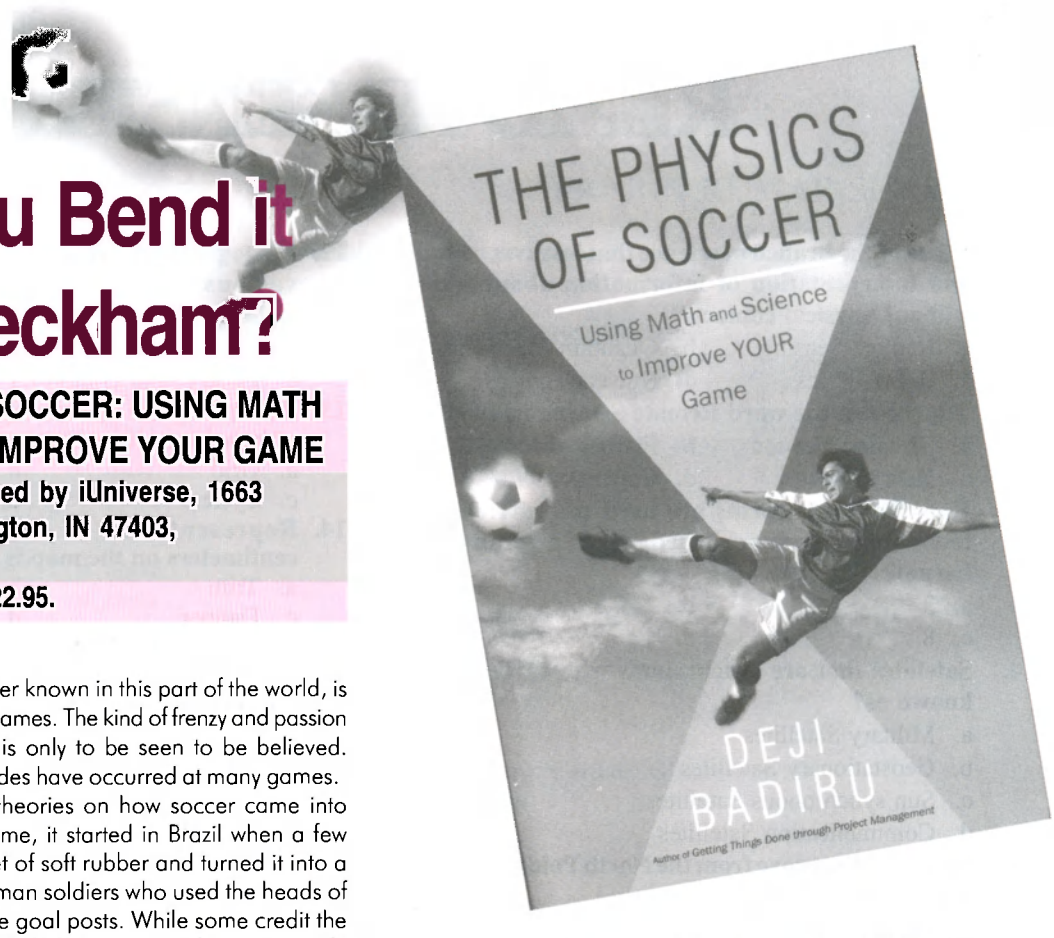
Can You Bend it Like Beckham?

THE PHYSICS OF SOCCER: USING MATH AND SCIENCE TO IMPROVE YOUR GAME
by Deji Badiru, published by iUniverse, 1663 Liberty Drive, Bloomington, IN 47403, www.iuniverse.com,
Pages 296, Price US $ 22.95.


THE PHYSICS OF SOCCER
Using Math and Science to Improve YOUR Game
DEJI BADIRU
Author of Getting Things Done through Project Management

Soccer, or football, as it is better known in this part of the world, is one of the most popular team games. The kind of frenzy and passion a game of soccer generates is only to be seen to be believed. Dangerous and tragic stampedes have occurred at many games.

There are innumerable theories on how soccer came into being. While according to some, it started in Brazil when a few children came across a bucket of soft rubber and turned it into a ball shape, others point to Roman soldiers who used the heads of enemies in a game with simple goal posts. While some credit the Mayan and Aztec Indians for originating soccer others give credit to China where soccer is said to have been played with leather balls in celebration of the emperor's birthday.

But whatever the origin, there is no getting away from the fact that the game is immensely popular the world over. And as you delve deeper into the game you find much of the soccer skills firmly rooted in scientific principles. That is the interface that Deji Badiru talks about in his book The Physics of Soccer: Using Math and Science to Improve Your Game. The credentials of the author? Well, he has been a soccer player for over forty years, soccer coach for eight years and has spent over thirty years as an engineering educator.

Soccer is a game played with a lot of passion, stamina and speed. Did you know that in a ninety-minute game of soccer, on an average, a player has ball possession for only about three minutes? So, skill, speed and technique are of paramount importance. And, according to the author, a close study of scientific principles will help players perfect their techniques.

For instance, a football player needs to be able to accelerate from zero to top speed to beat an opponent to the ball. The ball can come from any direction and so the ability to react quickly and take advantage of the ball requires proper starting motion and good acceleration. This component needs to be built into training programmes.

The soccer player also uses various parts of his body and also accessories to his advantage. For instance, the tip of the soccer shoe is often used as a wedge to separate the ball from the ground thereby lifting the ball up for skilful ball handling. Then, a skilful player can also use his outstretched leg and thigh as a ramp to roll the ball down onto his foot much like happens with an inclined plane.

Since soccer is a game of motion, a close look at the laws and principles of motion is also a must. Taking just one instance, according to the laws of motion, the longer a force acts on an object, the faster the object will move. This principle of force duration is applied in reverse when a soccer player receives a fast pass. The ball is brought under control more effectively by elongating the duration of the stopping force. This is accomplished by drawing the foot back as the ball makes contact with the foot.

And then there is the legendary banana kick perfected by David Beckham. He is reputed to be able to bend the ball around a wall of defenders and also trick the goalkeeper. The banana kick is the outcome of both skill and science. The ball is not kicked along the line of the center but rather across the ball with a twisting flick of the foot. The result is a spin on the ball that sends the ball on a trajectory often difficult for opponents to guess. Of course, delve deeper and you will find a whole lot of complex physics too involved such as gravity, drag and Magnus force.

Apart from developing his own stamina and speed, an intelligent player also studies the motion tendencies of opponents to find out their stability attributes such as center of gravity and so on.

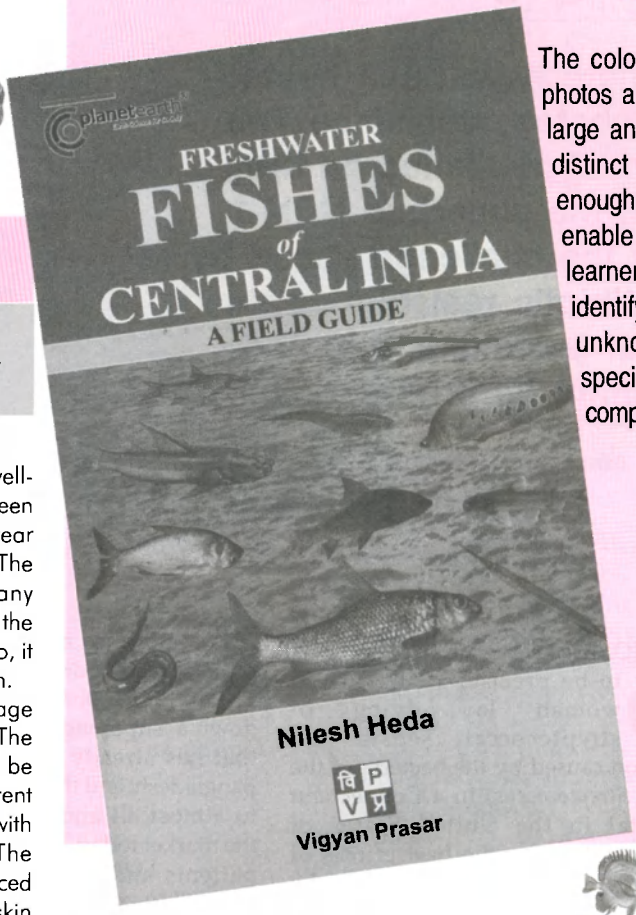
The author also details several scientific training practices that enable players to develop speed, judge the power they should impart to their kick to give the ball just the right force and height, and so on. And of course, the seventeen steps to supersonic soccer using Brian Peacock's doctrine.

An interesting book for those who have an interest in soccer and also a slight hang of science, which is necessary to be able to understand the various math and science principles the author introduces in the book.

Hasan Jawaid Khan

Fishy Business

FRESHWATER FISHES OF CENTRAL INDIA: A FIELD GUIDE by Dr. Nilesh Heda, published by *Vigyan Prasar*, A-50 Institutional Area, Sector-62, NOIDA-201 307, Paperback, Pages 169, Price Rs 125/-



The colour photos are large and distinct enough to enable a learner to identify an unknown species by comparison.

Vigyan Prasar has been playing a leading role in bringing out well-produced popular science books. The book under review has been brought out to celebrate the UN initiative under which the year 2008 was declared as the International Year of Planet Earth. The Planet Earth -2008 series of Vigyan Prasar includes many interesting titles and this particular volume joins the ranks with the potential of becoming a useful tool for students of Fishery. Also, it is an appropriate subject to celebrate the biodiversity on Earth.

It is a matter of only historical interest now, given the passage of years, but the reviewer was once a student of Fishery too. The University of Calcutta required that every student of Fishery be able to instantly recognize (taxonomically) at least 200 different species of fish...any of which could pop up for "identification with reason," during the final MSc practical examinations. The "preserved specimens" in the laboratory were mostly in an advanced state of decomposition; if nothing else formalin-saturated skin showed precious little of the original colour that is such an invaluable tool in identification. Not having a field guide, the reviewer had no other choice but to go where the fish were—the fish market!

Now, if a fish market is not celebrated for the calm and quiet that is mandatory for learning it is also not renowned for the fragrance of its ambience. The place is malodorous to put it mildly. Still, desperate situations call for desperate measures, so she bravely undertook many such missions to get better acquainted with fishy beings. Thankfully, the fish-sellers were repositories of enormous knowledge and with great enthusiasm they taught her enough to crack the exam. It was, therefore, with great pleasure that she received the book for review and read it eagerly.

The book is a treasure indeed for students of Fishery. The colour photos are large and distinct enough to enable a learner to identify an unknown species by comparison. The text matter alongside each species is precise, providing adequate information. The English common name is listed below the taxonomic nomenclature. Thoughtfully enough, local names have also been provided in a multiple of Indian languages. It is a little strange to see that while names that are common in Assam, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Punjab, Tamil Nadu, Uttar Pradesh etc. find a mention, local names from West Bengal are conspicuous by their absence.

This is a little strange because Bengal is celebrated for being in a state of permanent ichthyo-philia. Ichthyo-phagy is a way of life here, being associated with everything from the first celebratory feast when a baby tastes solid food (*annaprashan*) to weddings and the ritual meal signalling the ending of mourning (*mach-sparsha*, literal meaning fish-touching). This necessarily means that the people have names for almost all the species. Incidentally the English name for *Wallagu attu*, which is given as *Bo-al* in the book is the Bangla name for it. *Wallagu attu* is usually referred to as the Freshwater shark in English. It got its name for its aggressively carnivorous nature. There are many references in Bengali stories to a *Bo-al* being cut open to reveal the gold bangles or some similar token of a maiden gone missing. Perhaps in the next edition the Bangla names could also be incorporated. It will only add value to the book.

Another improvement in the next edition, and the reviewer is sure there will be multiple editions, calls for the intervention of a good copy editor. The language used in the book is erratic. Certain stretches have almost no errors while other parts are replete with mistakes ranging from the careless oversights to the gross. There are quite a few spelling mistakes. In the index of scientific names, the taxonomic names are not italicised. On page 11, it is mentioned that the Indian fish fauna is divided into two classes: Chondrichthyes (cartilaginous) and Osteichthyes (bony)...actually all fishes (including Indian ones are thus classified.

However, none of the aforementioned flaws detract strongly from the basic value of the book. Students using a field guide are usually not over-fussy about language. Since the book is above par in identifying the fishes of Central India, the reviewer is of the opinion that the flaws notwithstanding, it will prove to be of enormous value to students. However, the same relaxation of standards cannot be extended to any publication house and definitely not one of the stature of Vigyan Prasar, which would do well to re-edit the book from a language-perspective in the next edition.

Dr. Sukanya Datta, Scientist NISCAIR, posted to Director General's Technical Cell, CSIR-HQ. Email: sukanya@csir.res.in

There have been heated debates ever since *The Lancet* published an article on the superbug NDM-1. But the challenge posed by antibiotic resistant strains of bacteria is real and cannot be brushed aside.

A World Without Antibiotics?

VINAY B. KAMBLE

SOME 68 years ago, in March 1942 to be precise, a 33-year-old woman lay dying of streptococcal sepsis (an infection caused by the bacteria of the genus *Streptococcus*) in a Connecticut hospital in the United States of America. Despite the best efforts of contemporary medical science, the doctors could not get rid of her bloodstream infection. Somehow, they managed to obtain a small amount of a newly discovered substance called penicillin – discovered by Alexander Fleming in 1928 but not yet available off the shelf. They cautiously injected it into her. After repeated doses, her bloodstream was cleared of streptococci, and she recovered fully. The woman went on to live to the age of 91!

Sixty-six years after her startling recovery, in 2008, a report described a 70-year-old man in San Francisco, USA, with endocarditis (inflammation of endocardium-the lining membrane of the heart). This condition was caused by the *Enterococcus faecium* bacteria that were resistant to the antibiotic vancomycin, a drug of choice of the day. Despite administration for many days of the best antibiotics available for combating these vancomycin-resistant *Enterococcus faecium (VRE)* bacteria, physicians were unable to sterilise the patient's blood, and he died with the bacteria still present in his blood.

In a recent issue, the British medical journal *The Lancet Infectious Diseases* (published online on 11 August 2010), published a paper revealing the rapid spread of drug-resistant bacteria. The authors reported that they tracked down a 'superbug' to Indian hospitals, that has already spread to Pakistan, Bangladesh, and the UK, and is resistant to almost all antibiotics available in the market today. This superbug infects patients and causes multiple organ failure. We may note that ever since the paper was published, it has generated heated debates around the world on the prospects of the superbug spreading across the world, and in particular, on the booming Indian medical tourism industry. The authors also posed a question - "Is this the end of antibiotics?" Does this sound like an exaggeration? Perhaps not!

Today, for patients infected with multidrug-resistant bacteria, there are no magic bullets available. We have come almost a full circle and arrived at a point as frightening as the pre-antibiotic era. Today, it is difficult, almost impossible, to think of undertaking surgeries, transplantations, cancer chemotherapy, care of HIV-infected or the critically ill, without effective antimicrobial agents. However, a few microbes (bacteria, viruses, and some parasites) have adapted to a point where they pose serious clinical challenges for humans. And, for sure, bacteria are the champions of evolution! In just a couple of generations, what once appeared to be miracle drugs have been reduced to ineffectiveness by the very bacteria they were designed to knock out! How did it all happen?

Antibiotics – 3,000 years old

Almost each one of us has used an antibiotic – for a bad cut, or to get over pneumonia, or some other type of infection. Antibiotics are chemicals, which when introduced into our body stop the growth of certain kinds of germs, called bacteria, and help our body fight disease. Indeed, human beings have been using antibiotics for over 3,000 years. The Chinese and the Egyptians stumbled upon some moulds that could be used as a cure to treat rashes and wounds. Sumerians used beer soup mixed with snakeskins and turtle shells. Indians and Greeks used many herbs to heal several ailments. All of these natural treatments contained some sort of antibiotic. With passage of time, people began to gain some insight into diseases. In the 1860s, Louis Pasteur (1822-1895) showed that many diseases were caused by bacteria. He later recognised that one type of bacteria could be used to kill another type of bacteria.

A Breakthrough

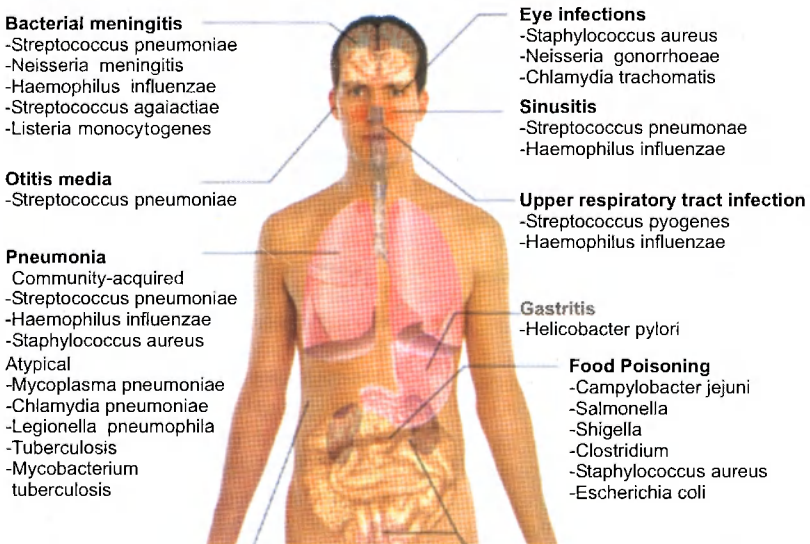
In 1929, Sir Alexander Fleming (1881-1955), a Scottish bacteriologist, made the real breakthrough in antibiotics. He went on a vacation and left a petridish of staphylococci bacteria uncovered. When he returned, he noticed that there was mould growing on it. Upon further examination, he saw that the area around the mould had no bacteria growing, thanks to a chemical produced by the mould. The name of the mould was penicillium, and hence

It has been a continuous war between man and microbes – both vying to outwit each other. But, eventually it is the microbe that seems to be gaining the upper hand – and for which we are largely responsible.

the chemical produced by the mould was named penicillin - the first ever substance recognised as an antibiotic. Penicillin worked against pneumonia, scarlet fever, and several other diseases; however, it had no effect on germs that caused typhoid, influenza, and many other diseases. As a result, scientists had to continue their search for other antibiotics. Mass production of penicillin, however, began only in the mid-1940s.

After penicillin came the discovery of the sulpha drugs. They came from Prontosil, a substance used as a dye. When introduced into the body, Prontosil changes into an active germ-killing drug called sulphonamide. This drug could cure pneumonia, scarlet fever, and blood poisoning. In the late 1940s through the early 1950's, streptomycin (used in treatment of tuberculosis, typhoid fever and other infections), chloramphenicol (used in the treatment of typhoid fever, some form of meningitis and as drops or ointments for skin, eye, or ear infections), and tetracycline (prescribed to treat urinary infections, pneumonia, diseases such as typhus, sexually transmitted infections and conjunctivitis caused by the "chlamydia" bacteria) were discovered and introduced as antibiotics.

However, it is interesting to note that almost immediately after penicillin was introduced, resistance in certain strains of staphylococci was noticed. By 1950's it was apparent that tuberculosis bacterium was rapidly developing resistance to streptomycin, which had commonly been used to treat it. In 1953, during a *Shigella* outbreak in Japan, a certain strain of dysentery bacillus was found to be resistant to chloramphenicol, tetracycline, streptomycin, and the sulphonamides.

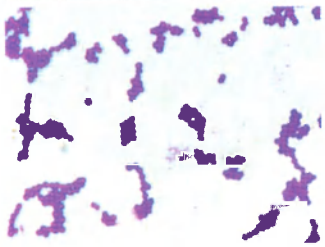


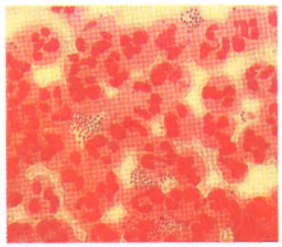
Bacterial infections and main species involved
(Source: Bacteria, Wikipedia)

Bacteria and Antibiotics

When, one gets a cut or is injured, it results in breakage or opening of the skin barrier, through which some opportunistic pathogens gain entry into the body. If the person is healthy and has a strong immune system, it fights off the unwanted entry. However, if a person is weak or the pathogen is virulent, it results in development of a disease caused by bacteria. The bacteria that cause health problems in human beings are called human pathogenic bacteria. They can also gain entry into the body through food, water, air, saliva and other body fluids.

Bllions of bacteria belonging to hundreds of different species - both identified and unidentified - inhabit the human body, forming an ecological community living in a state of equilibrium. Their number in our body is nearly 10 times higher than the number of cells in our body! Most of them are benign to the host and some even provide valuable services.





***Staphylococcus aureus*: Gram-positive** (extreme left)

***Neisseria gonorrhoeae*: Gram-negative** (left)
(Source: Photo gallery of pathogenic bacteria, Wikipedia)

The use of some broad-spectrum antibiotics can, however, disturb the balance dramatically, reducing the numbers of friendly bacteria. In such a situation, other kinds of potentially harmful bacteria, normally present only in small numbers, can overgrow, and may even cause a super-infection.

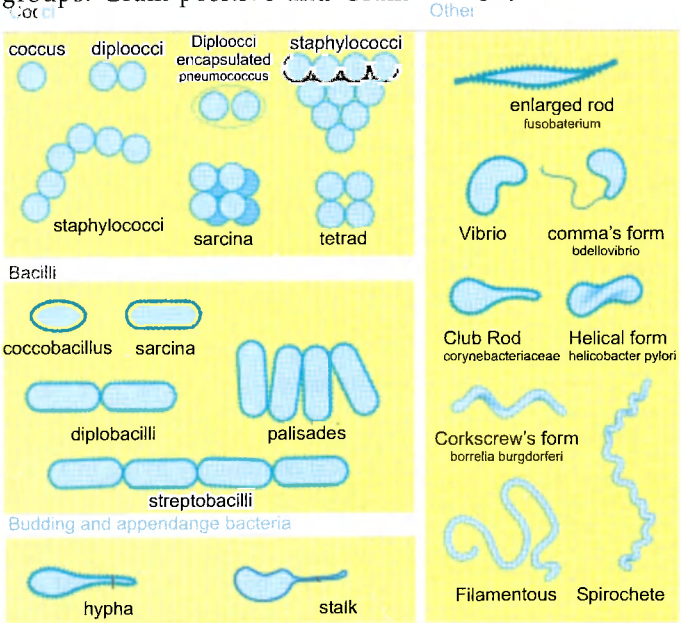
Next, the resistant bacteria proliferate when a population of microbes containing both susceptible and resistant bacteria is exposed to an antibiotic within the host. Susceptible bacteria succumb and resistant bacteria proliferate. However, if the full course of antibiotic is not completed, the bacteria that survive the drug mutate and become resistant to that antibiotic. This is why patients are advised to complete the full course of antibiotic treatment. Use of antibiotics in animal feed is an additional cause of antibiotic resistance. Moreover, bacteria from livestock can get into our water systems.

Gram-positive & Gram-negative Bacteria

Bacteria are broadly classified into two groups: Gram-positive and Gram-negative. A technique for preliminary identification of bacteria was developed by Hans Christian Joachim Gram (1853-1938), a Danish physician, in which a violet dye is applied, followed by a decolourising agent and then a red dye. The cell walls of bacteria that retain the first dye and appear violet are termed the Gram-positive bacteria, while those that lose it appear red and are termed Gram-negative bacteria.

Gram-positive bacteria are encased in a plasma membrane covered with a thick wall of peptidoglycan. Gram-negative bacteria are encased in a triple-layer, the outermost layer containing lipopolysaccharide. Because of their thick cell wall, Gram-positive bacteria were considered more difficult to treat than the Gram-negative ones, but this is no longer true. In fact, it is the Gram-negative bacteria that have now developed resistance to most potent antibiotics.

Bacteria could be rod-shaped (bacilli), spherical (cocci), or may even have curved walls (spirilla). They even may have a tendency to bunch like grapes as in the case of staphylococcus.



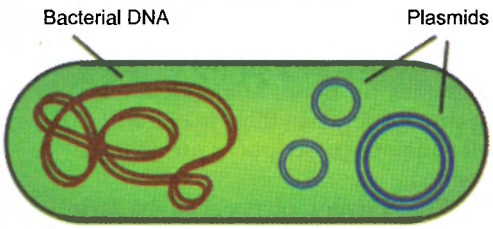
Bacteria with different shapes (left)
(Source: Bacteria, Wikipedia)

Survival of the Fittest

Bacteria do not have a membrane-bound nucleus, and their genetic material is typically a single circular chromosome located in the cytoplasm in an irregularly shaped body called the nucleoid. The nucleoid contains the chromosome DNA (deoxyribonucleic acid) with associated proteins and ribonucleic acid (RNA). It also contains plasmids, which are DNA molecules. Plasmids are separate from, and can replicate independently of, the chromosomal DNA. Further, like all living organisms, bacteria contain ribosomes for the production of proteins, though their structure is different from ribosomes found in other organisms.

The indiscriminate and improper use of antibiotics results in a survival-of-the-fittest selection process for bacteria, which can both inherit and acquire resistance to drugs, through mutation or by sharing DNA. This is just as in normal Darwinian evolution, but accelerated umpteen times by the division of millions of them. Further, this also holds true for other microbes (an umbrella term for microscopic organisms that include bacteria, viruses, fungi and parasites). An infection treated with the wrong drug or for too short a time results in most bacteria being killed while the resistant ones survive to multiply. Antibiotics are ineffective against viral infections; if used they promote the growth and spread of resistant microbes in patients, their families, and the community. The lack of effective monitoring and enforcement of controls on the sale and use of antibiotics is cited by the World Health Organization (WHO) as one of the main causes of growing resistance of the world's microbes to antimicrobial drugs.

Bacteria and other microbes are transmitted readily from person to person and global travel has only contributed to the dissemination of novel pathogens, including drug-resistant strains. It is important to note that crowding also contributes to the dissemination of novel pathogens. Hospitals and nursing homes are particularly ideal environments for the exchange of microbes including drug-resistant strains. Cancer treatments and use of other immunosuppressives (drugs that reduce body's normal



A bacterium with plasmid enclosed showing chromosomal DNA and plasmids (right)

immune response) such as those used for transplant patients add to the problem. So does human immunodeficiency virus (HIV) that leads to AIDS.

Further, surgery or catheterisation that breaches the protective barrier of the skin increases the risk of infection. In crowded cities, and especially in countries where adequate sanitation may be lacking, microbes are brought by immigrants from diverse locations. They can spread rapidly, particularly when immunisations and health care are inadequate.

Emergence of the Superbugs

As early as 1945, in an interview with *The New York Times*, Fleming warned that the misuse of penicillin could lead to selection of resistant forms of bacteria. Fleming had experimentally derived such strains by varying the dosage and conditions upon which he added the antibiotic to bacterial cultures. Fleming had warned that the drug carried a large potential for misuse, especially with patients taking it orally at home, and that inadequate treatments would likely lead to mutant forms. How his words have proved to be prophetic!

When first discovered, antibiotics were thought to be a miracle cure and they literally were. Infections that were fatal were reduced to mere inconveniences. In the early years, new antibiotics were developed faster than bacteria developed resistance to them. But the bugs caught up fast. In the 1950s and 60s, many new classes of antibiotics were discovered. In the 1980s and 1990s, scientists could only manage to make improvements within classes. Today, some low-grade hospital bugs have become resistant to most antibiotics.

Penicillin and streptomycin were deployed in the early 1940s. Resistance to penicillin was observed in mid-1940s while resistance to streptomycin was observed in the late 1950s. Tetracycline was deployed in the late 1940s, but resistance to it was observed in mid-1950s. Erythromycin had a relatively long innings. Developed in the mid-1950s, resistance to it was observed in the late 1980s. Resistance to Methicillin, developed in late 1950s, was observed in the early1960s. Resistance to Ampicillin, developed in the mid-960s, was observed in the mid-1970s.

Hospitals are not the only breeding grounds for these "superbugs", as they have come to be known. A marked rise in drug-resistant bugs has been observed in community homes and other places that are home to vulnerable groups of people. Worldwide, a new drug-resistant strain of tuberculosis is causing concern, particularly as the disease is enjoying resurgence. Even if resistance to some antibiotics does not prevent treatment because others are available, it still costs a large sum of money. Alternative drugs are more expensive and have greater side effects.

As of now, we continue to face growing resistance among Gram-positive and Gram-negative pathogens that cause infection in the hospital and in the community. It is reported that the pathogens such as *Enterococcus faecium* (Gram-positive), *Staphylococcus aureus* (Gram-positive), *Klebsiella pneumoniae* (Gram-negative), *Acinetobacter baumanii* (Gram-negative), *Pseudomonas aeruginosa* (Gram-negative), and Enterobacter species (Gram-negative) – the so-called ESKAPE pathogens – cause the majority of US hospital infections today and effectively "escape" the effects of antibacterial drugs.

Data show rapidly increasing rates of infection due to methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *E. faecium* (VRE), and fluoroquinolone-resistant *P. aeruginosa*. More people now die of MRSA infection in US hospitals than of HIV/AIDS and tuberculosis combined. Furthermore, pan-antibiotic-resistant (that is, resistant to all antibiotics) infections now occur frequently. Several highly resistant Gram-negative pathogens - namely *Acinetobacter* species, multidrug-resistant (MDR) *P. aeruginosa*, and carbapenem-resistant

Misuse of antibiotics could lead to selection of resistant forms of bacteria

Klebsiella species and *Escherichia coli* — are emerging as significant pathogens in both the United States and other parts of the world.

Superbug NDM-1

Of late, in the Indian sub-continent, Gram-negative *Enterobacteriaceae* strains, resistant to the powerful antibiotic carbapenem, are becoming more widespread, especially in India and Pakistan. Incidentally, the antibiotic carbapenem is considered to be the last line of treatment for infections caused by Gram-negative bacteria. How does the resistance arise?

The resistance arises on account of a new gene that is responsible for production of the *metallo-beta-lactamase* enzyme that makes the antibiotic carbapenem ineffective. This drug-resistant bacterial gene, the so-called superbug, was named *New Delhi Metallo-beta-lactamase-1* (NDM-1) in 2009 when it was first identified in a Swedish national admitted to a hospital in New Delhi.

The Lancet paper reported that 44 isolates with NDM-1 were identified in Chennai, 26 in Haryana, 37 in the UK, and 73 in other places in India and Pakistan. NDM-1 was mostly found among the bacterial species *Escherichia coli* and *Klebsiella pneumoniae*, which were highly resistant to all antibiotics except to tigecycline and colistin. *K pneumoniae* isolates from Haryana were clonal (structurally identical), but bacteria producing NDM-1 from the UK and Chennai were clonally diverse. The findings in Haryana are especially worrisome since the isolates were from community-acquired infections, suggesting that NDM-1 is widespread in the environment. It could hence lead to epidemics for which we hardly have any antibiotics!

The study further reported that the carbapenem-resistant strain was seen in 37 UK patients, who had undergone elective and cosmetic surgery in India and Pakistan. We may note that prior to this study, a study published in

Personal hygiene is the best way to avoid spreading of harmful microbes

Wash Fruits & vegetables Properly

March 2010 in the *Journal of Association of Physicians of India*, 22 cases of carbapenem-resistant NDM-1 were collected within a span of just *three months* from a Mumbai hospital. Most isolates carried the NDM-1 gene on plasmids (circular strand of DNA in the bacterium). The potential of NDM-1 to be a worldwide public health problem is great, and co-ordinated international surveillance is needed.

Resistance to *extended-spectrum beta-lactamase* (ESBL) drugs like third-generation cephalosporins is less than 15% in developed countries. While in India, it is between 60 and 70%! For treatment of ESBL infections, carbapenem a reserved antibiotic and the last line of treatment - is the drug of choice as it has the lowest resistance rates and the broadest action against Gram-negative infections. However, its indiscriminate use has played a major role in the development of the carbapenem-resistant gene, including the new NDM-1 strain.

NDM-1 was unknown until a few years ago, but has begun to show up in the last three years. NDM-1 is, in all probability, still a hospital-acquired infection. Drug-resistant NDM-1 strains are a cause for worry because very few drugs are available to treat Gram-negative infections. NDM-1 gene is carried in the plasmids of the Gram-negative bacteria and hence its prevalence could increase quite fast. These plasmids can move from one bacterium to another, and even to different species.

Era of Antibiotics Coming to a Close?

In many ways, this may be true. Since development of a new antibiotic requires huge investment and relatively long time period to develop and market, the pharmaceutical companies have not shown a great deal of enthusiasm for difficult antibiotic research since the 1990s. People take heart medicines for life, unlike the antibiotics that they may take for a week or so. And because resistance means the drugs become useless after a while, there is just not much money in it!

There are no antibiotics in the pipeline either that have activity against NDM-1 producing *enterobacteriaceae*. May be, there is a bleak window of 10 years, where we shall need to use the antibiotics we have very wisely, according to the lead author of the study published in *The Lancet*. This is with the assumption that drug companies can and will get moving on discovering new antibiotics to treat the new bacterial infections during this period.

Whatt could we do to reverse the growth of the resistant bacteria, then? Here are a few things you could keep in mind:

- Antibiotics should be used only when they are truly needed and that too only under the supervision of a physician.
- It is essential to complete the full course of antibiotic therapy to ensure that all the pathogenic bacteria are killed.
- Do not skip doses since this causes the level of antibiotic in the blood to drop, giving a chance to some bacteria to survive and develop resistance to this drug.
- Physicians should not prescribe antibiotics even when they are not required.
- Also do not "demand" antibiotics from physicians or purchase from the friendly pharmacist over the counter – without any prescription – even for colds and other viral infections against which antibiotics are ineffective.
- Consider seeking non-antibiotic therapies for minor ailments. Indeed, approximately one third to one half of all antibiotic prescriptions are not even needed.
- The amount of resistant bacteria people acquire from food is significant; hence it is advisable to wash raw fruits and vegetables thoroughly.
- Washing hands frequently with regular soap and warm water is the best way to avoid spreading harmful microbes.

It has been a continuous war between man and microbes – both vying to outwit each other. But, eventually it is the microbe that seems to be gaining the upper hand – and for which we are largely responsible. There is need to formulate stricter national control policies, strict control on administration of drugs, antiseptic conditions in hospitals and clean environment. But, the most important is education of people, including practising physicians and medical students, to prevent rampant and indiscriminate use of antibiotics.

There is still a good chance of keeping the prevalence low, provided a two-pronged approach is adopted: instituting a national antibiotic policy that restricts the use of carbapenem and other higher-end antibiotics to hospital settings and only for patients with severe infections, and having a national registry of drug-resistant strains. May be, then there could be a hope and way out of this impasse.

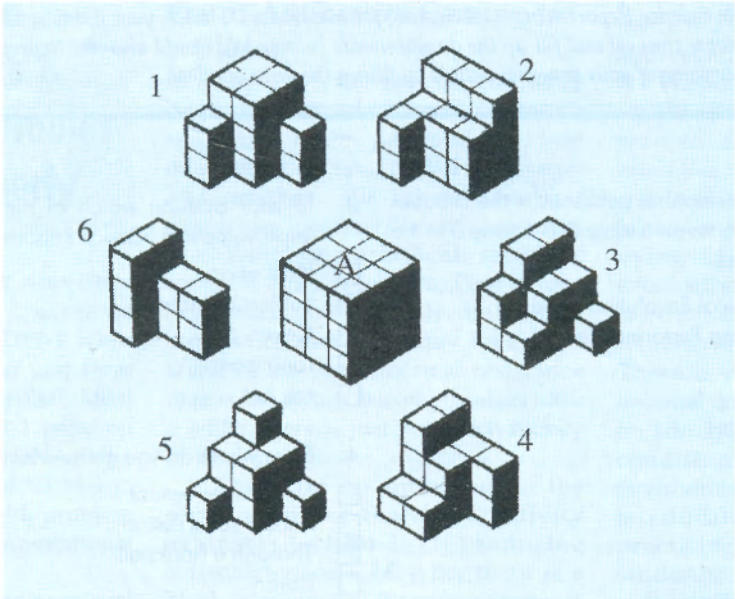
Finally, one last comment. Ever since the publication of *The Lancet* paper, there have been heated debates the world over. In the developed countries, due to the challenges posed by the NDM-1 superbug, while in India because it could affect it's booming medical tourism industry. But one must not lose the focus. The challenge posed by NDM-1 is very real and the efforts must begin in order that we do not lose the battle against bacteria, even if we don't win it!

Dr. Vinay B. Kamble is a science communicator based at Ahmedabad. Earlier he was Director, Vigyan Prasar, and Adviser, Department of Science and Technology, New Delhi. Address: 16, Aangan Apartments, Near L.J. Commerce College, Vastrapur, Ahmedabad-380015, Gujarat; Email: vinaybkamble@gmail.com

Prize Puzzle

BROKEN CUBES

Cube 'A' has been broken into two pieces. Out of the six given options, which two pieces are the right combinations to make cube 'A'?



ANSWER: Option No.: ..... and **Option No.:** .....

Contributed by Mr RaashidJamal, Nana Saheb ka Bara, Bazaria PO, Dholpur, Rajasthan-328001.

There are three prizes of Rs. 500/– each for three correct entries. In case there are a large number of correct entries, the prize winner will be selected through a draw of lots. The decision of the Editor, *Science Reporter*, will be final.

Last date for the entries to reach us: 30-10-2010

Puzzle Corner
Science Reporter
National Institute of Science Communication And
Information Resources, CSIR, Dr. K.S. Krishnan Marg
New Delhi-110012

Your Name : .....

Address : .....

.....

.....Pin Code : .....

Age : .....Sex : .....

Occupation : ☐ Student ☐ Housewife ☐ Teacher ☐ Professional ☐ Retired ☐ Other

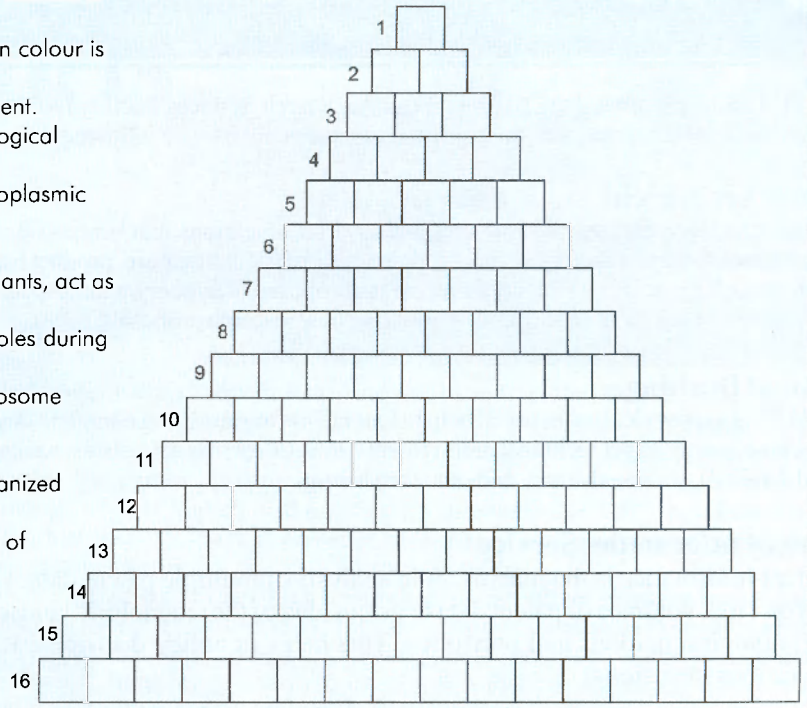
Educational Level: ☐ Primary ☐ Secondary ☐ Graduate ☐ Postgraduate

*Please fill up the questionnaire at the back

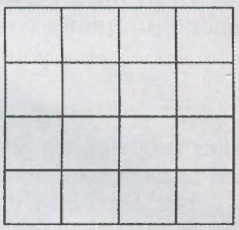
*Please note: Now you can even send your answers on a photocopy of this page.

PYRAMID OF GENETICS

1. In genetics, the dominant character for Tallness is represented by this letter.
2. Homozygous dominant alleles for green colour is represented like this.
3. Mendel chose this plant for his experiment.
4. An inherited factor that determines biological character of an organism is called...
5. Particles in Paramecium, involved in cytoplasmic inheritance.
6. Jacob and Monad Concept.
7. Extra chromosomal hereditary determinants, act as vector too.
8. Chromosomes move to the opposite poles during this phase of cell division.
9. Group of characters that shows chromosome number, size and shape in a species.
10. Primary constriction of a chromosome.
11. Organisms that do not have a well-organized nucleus and cytoplasmic organelles.
12. Enzyme that cleaves interstitial position of nucleotides.
13. Process involving genetic information from DNA to mRNA.
14. Animals having female characters in one part and male characters in the remaining part.



Contributed by Dr K. Venkataraman, A-T-2, Porkudam Apartments, Bypass Road, Madurai-10



No Square Puzzle

There are 30 squares of different sizes made up by matchsticks. After removing 9 sticks from the figure, no complete square will be left. How can you do this?

Contributed by Mr RaashidJamal, Nana Saheb ka Bara, Bazaria PO, Dholpur, Rajasthan-328001.

Solutions to the puzzles published in the August 2010 issue:

PRIZE PUZZLE: Knights & Knaves

No inhabitant can say that he or she is a knave, as knaves always lie and would say they are knights, and knights would tell the truth. Following this, B has told a lie and thus B is a knave. C told the truth and is a knight.

Match the Biologists

1. M	2. Q	3. R	4. S
5. O	6. A	7. G	8. P
9. N	10. K	11. J	12. T
13. L	14. I	15. H	16. F
17. E	18. D	19. C	20. B

Colour Quiz

1.	RED	2.	ORANGE
3.	INDIGO	4.	GREEN
5.	BLUE	6.	VIOLET
7.	YELLOW		

RAINBOW

The names of the prizewinners based on a draw of lots from among the correct entries are:

1. A. Aditi, G-23, Aurobindo Colony, BHU Campus, Varanasi-221005 (U.P.)

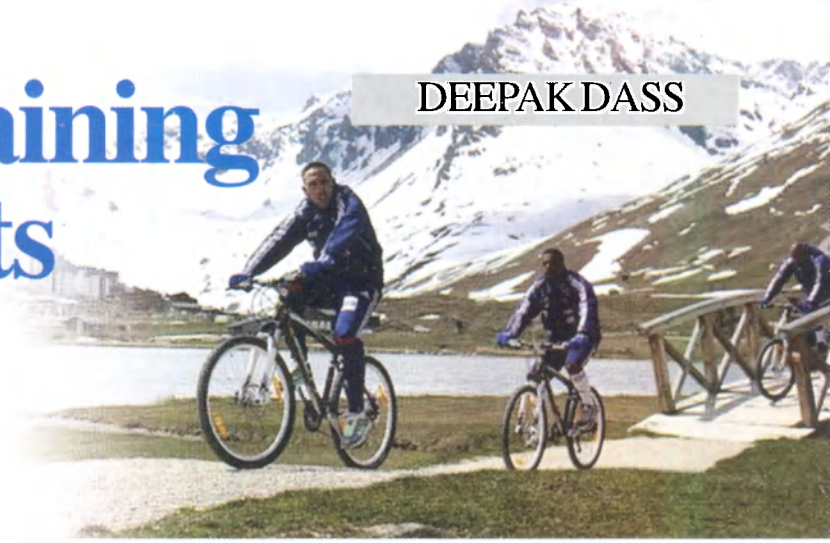
2. Jaspinder Singh, #55L, Baba Deep Singh Nagar, Near Springdales School, Sangrur, Punjab-148001

3. Prakhar, 64/154, Gadariya-Mohal, Kanpur-208001 (U.P.)

Congratulations all the winners!

Altitude Training in Sports

DEEPAK DASS



It is the 2008 Beijing Olympics, the men's 10,000 m event. The race lasts for about 27 minutes. Gold medalist Kenenisa Bekele (Ethiopia) times 27:01.17, the silver medalist Sileshi Sihine (Ethiopia) runs 27:02.77, and the bronze medalist Micah Kogo (Kenya) finishes with a time of 27:04.11.

Incredible as it may seem, these narrow time differences are decisive in the final medal tally. That is why most contemporary elite athletes and coaches alike feel the need to integrate some form of training that will augment their ability to compete successfully at international level in such closely contested competitions.

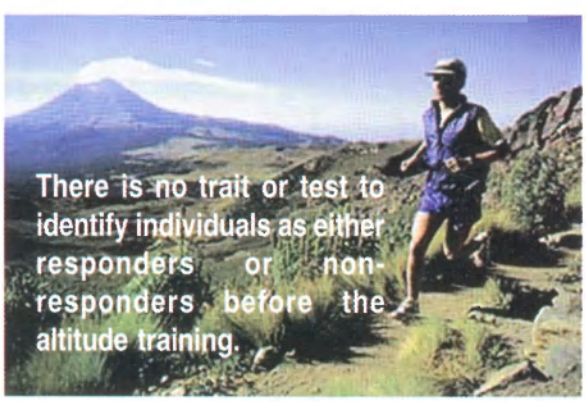
Altitude Training is one of them. Although still controversial, it finds support in some quarters. The cycling legend Lance Armstrong has been a strong proponent of altitude training.

Up There

As one climbs higher from the sea level air pressure decreases. The air at higher altitude is rarefied. However, the percentage of oxygen, which is approximately 21%, is similar at all elevations. This means the individual pressure or the partial pressure of oxygen in the atmosphere lessens. So at high altitudes every breath contains fewer and fewer molecules of oxygen.

So how does this affect our physiology? Oxygen moves from our lungs to our blood stream following a specific pressure gradient. At sea level where the average pressure is 760 mmHg the partial pressure of oxygen (160 mmHg) is higher in the air one breathes than the partial pressure of oxygen in the blood. So, due to the pressure gradient oxygen is transported from the lungs to the blood. At higher elevations this vital pressure gradient weakens, flagging the transport of oxygen to the blood stream. This reduced amount of oxygen available promotes a complex physiological response, depending on the severity and rate of induction to higher altitude. Thanks to the resilience of the human body, given time the body can adjust to the reduced oxygen. This adjustment is termed *acclimatization*—a reversible and non-inheritable physiological adjustment to improve tolerance to diminished oxygen, in this case. Of course, the rate of acclimatization varies among individuals.

So what exactly happens during acclimatization? There is a profuse physiological activity to bring about acclimatization. These changes are body's way of trying to compensate the decreased levels of oxygen. Some of the most distinct ones are increase in the depth and frequency of respiration and increase in red blood cells. Certain proteins called hypoxia-inducible factors are increased by low oxygen and this is influential in stimulating the release of a hormone called erythropoietin (EPO) from the kidney. EPO in turn increases the production of red blood cells (RBC). The increase in oxygen carrying RBCs therefore improves oxygen delivery to tissues. Altitude exposure also increases 2.3 DPG, a substance that makes oxygen more available to the muscles.



Scientists working in the field of altitude training have sought to harness these enhanced adaptive mechanisms to subsequently improve performance of some endurance sports at sea level.

Early research of altitude physiology from a sports activity perspective was mainly mountaineering and climbing. In 1968, the Mexico Olympics took place at elevations above 7,000 ft., a first major athletic event at such an altitude. It was noticed particularly in endurance track events, that altitude born athletes dominated. Athletes who had acclimatized prior to the games fared better than non-acclimatized athletes. These outcomes created a flurry in sports science, thus launching a lot of interest and research in altitude training.

Types of Altitude Training

Altitude training is still in its formative state, and its benefits are still a matter of debate. Over the years different protocols have come up, older techniques have been revamped and several variations have been incorporated and customized.

Live High and Train High

This is a more conventional type of training where athletes primarily live and train at altitude. The rationale is that it is the stimulus of altitude exposure probably that drives an already well-trained athlete up to that

Athletes who had acclimatized prior to the games fared better than non-acclimatized athletes.

'next' level of performance. Many Kenyan runners have trained using this technique.

Different scientific studies have shown mixed results where study protocols have varied with reference to elevation of altitude and period of training. The main drawback is that if athletes do not adapt well to altitude they may suffer from altitude illnesses. There have also been reports of reduced exercise intensity. Prolonged stay at altitude may have its own set of ill effects on the body.

Live High and Train Low

In the live high and train low model the athlete lives in hypoxic state (less percentage of oxygen as in high altitude) but does all training in normoxic conditions (normal oxygen content as in sea level). In other words, the athlete lives/sleeps at natural altitude or altitude sleeping tents that stimulate hypoxia and trains at sea level.

Dr Benjamin Levine (Presbyterian Hospital, Dallas) and Dr James Stray-Gundersen (University of Utah) in a seminal research work presented substantial evidence highlighting the advantages of living high and training low. They compared three groups of athletes, the first group *lived low and trained low*, the second group *lived high and trained high*, the last group *lived high and trained low*.

A significant performance benefit was found in the last group, with positive hematological physiological changes. Since then other studies have shown similar findings.

Fundamentally, live high and train low model is based on the theory that athletes can at the same time experience the benefit of altitude/hypoxic acclimatization and sea level training.

Lately, other variations to this model have also been studied, where one lives at altitude but trains at sea level while breathing supplemental oxygen (greater than 21% oxygen). However, the real benefits of training with supplemental oxygen are yet to be confirmed.

Intermittent Hypoxic Training (IHT)

By definition, intermittent hypoxia means repeated bouts of hypoxia exposures interspersed with episodes of normoxia, in an endeavour to replicate some vital elements of altitude acclimatization. This method originated in the erstwhile USSR where its benefits were explored in the fields of aviation and clinical medicine. The hypoxic exposure is generally done in simulated conditions using "hypoxicators" and hypoxic/altitude tents.

Recently it has found support in the field of athletic performance. When intermittent hypoxia is used as a specific protocol to enhance sports performance it is generally termed Intermittent Hypoxic Training or IHT. Dr John Hellemans a sports medicine practitioner from New Zealand in a pilot of a group of endurance athletes found that IHT significantly improved hematological factors related to oxygen transport and performance.

Caveats in Altitude Training

Who should get altitude exposure? How high/severe should the exposure be? What should be the duration of exposure? What is the best technique? In the science of altitude training these are called dose, intensity, frequency and duration, of which there is no set consensus among researchers.

Since altitude acclimatization has a lot of individual variation, the issue of *responders* and *non-responders* has continuously plagued researchers in this field. Responders are those who benefit from the training while non-responders do not show improvement in their performance after the altitude training. Unfortunately, there is no trait or test to identify individuals as either responders or non-responders before the altitude training. Some scientists have suggested factors like genetics and initial iron storage status being responsible for responder or non-responder.

Ethical Issues

The Executive Committee and Foundation Board of World Anti-Doping Agency (WADA) had considered placing "artificially induced hypoxic condition" on the 2007 Prohibited List of Substance/Methods. However, it was later not included, rather it drew a lot of flak from scientific quarters for contemplating the ban.

Despite extensive research in the area researchers are still grappling with many unsettled queries like the mechanism of improvement, 'dose', duration and intensity of altitude exposure, responder versus non-responders, etc. Notwithstanding the existing debates about the efficacy of altitude training in sports, it continues to be used as a key adjunctive tool for the training of competitive athletes throughout the world looking for that extra edge to win.

Mr Deepak Dass is with the Defence Institute of Physiology and Allied Sciences (DIPAS), Lucknow Road, Timarpur, Delhi-110054; Email: dassdeepak69@yahoo.com

Nightcap Oak: Untouched by Time Elapsed

The Nightcap Oak (*Eidothea hardeniana*; Family Proteaceae) is an Australian rainforest tree. It bears faintly fragrant, creamy-white flowers with primitive characteristics, indicating an ancient evolutionary lineage.

The fruits round, dull golden-yellow in colour. The bark is grey with fine horizontal crinkling. Adult leaves are dark green, smooth along the edges, with distinctive pale veins. Leaves on juvenile plants are orange to red and strongly toothed. Genus *Eidothea* is named after a daughter of the Greek God Proteus, who could change his form at will; a trait shared by members of the Family Proteaceae. Their juvenile foliage differs from the mature form—a fact that delayed the identification of the Nightcap Oak by many years.

The Nightcap Oak's claim to fame is that it dates back to prehistoric Gondwanaland. These are living fossils—members of the rainforests that once covered the ancient super-continent that was Australia, Africa, South America, Antarctica and New Zealand combined. Fossil fruits very similar to those of living *Eidothea* species have been discovered from 15-20 million years old Australian rocks, indicating that the Nightcap Oak is an evolutionary relict of a time when rainforests covered vast areas of Australia.

The Nightcap Oak remained unchanged despite the upheavals that accompanied the passage of time; although their range was seriously restricted, and the population too dwindled. Today, just one clump of mature trees exists in the world. Botanist Robert Kooyman first collected leaf-specimens in 1988, but had to wait till 2000 for proper identification.

Actually, the story begins in 1875 when Botanist Baron Ferdinand von Mueller examined a 15-20 million year old fossil. These fossil fruits were so unlike those of other Proteaceae that Mueller misidentified them and named the species, *Xylocaryon lockii*. Then, nearly one hundred years later, botanist Bernie Hyland found similar fruits on the rainforest floor in Queensland. It took him two decades to finally locate the trees that produced the fruit and to formally identify it as *Eidothea zoexylocarya* in 1995. These trees were named *zoexylocarya*, due to many similarities with the fossil plant found in 1875.

Reportedly, Kooyman's colleague Jeff Tracey (while working with Len Webb over 30 years ago) first collected a specimen of the Nightcap Oak. It was sent to the Queensland Herbarium for identification and identified as a species of *Corynocarpus*. Initially, the 1988 specimens collected by Robert Kooyman were also tentatively placed under *Corynocarpus*. The lack of flowers or fruits prevented more accurate description of the species.

In 2000, Kooyman and his colleague Andrew Benwell, spotted both juvenile plants and large canopy trees. The fruits showed similarities with the fossil fruits found in 1875 and also to the fruits of *Eidothea zoexylocarya*. Subsequently, Proteaceae specialist Peter Weston and Robert Kooyman formally described the species as *Eidothea hardeniana*. The term *'hardeniana'* honours botanist Gwen Harden. *Eidothea zoexylocarya* and *Eidothea hardeniana* are the only two species of *Eidothea* known today.

It is said that hiding in plain sight is the best way to remain unnoticed. Surely, the Nightcap Oak that can grow to heights of 40 m and exists in a rainforest that "has been scoured to within an inch of its life by some very good botanists," is a super-specialist when it comes to learning how to stay away from the public eye. Interestingly, this is exactly how scientists would like them to stay. The exact location of these trees is a closely guarded secret as the rush of public attention could jeopardize their survival in a world they have inhabited for millions of years.

Reportedly, Kooyman's colleague Jeff Tracey first collected a specimen of the Nightcap Oak. It was sent to the Queensland Herbarium for identification and identified as a species of Corynocarpus

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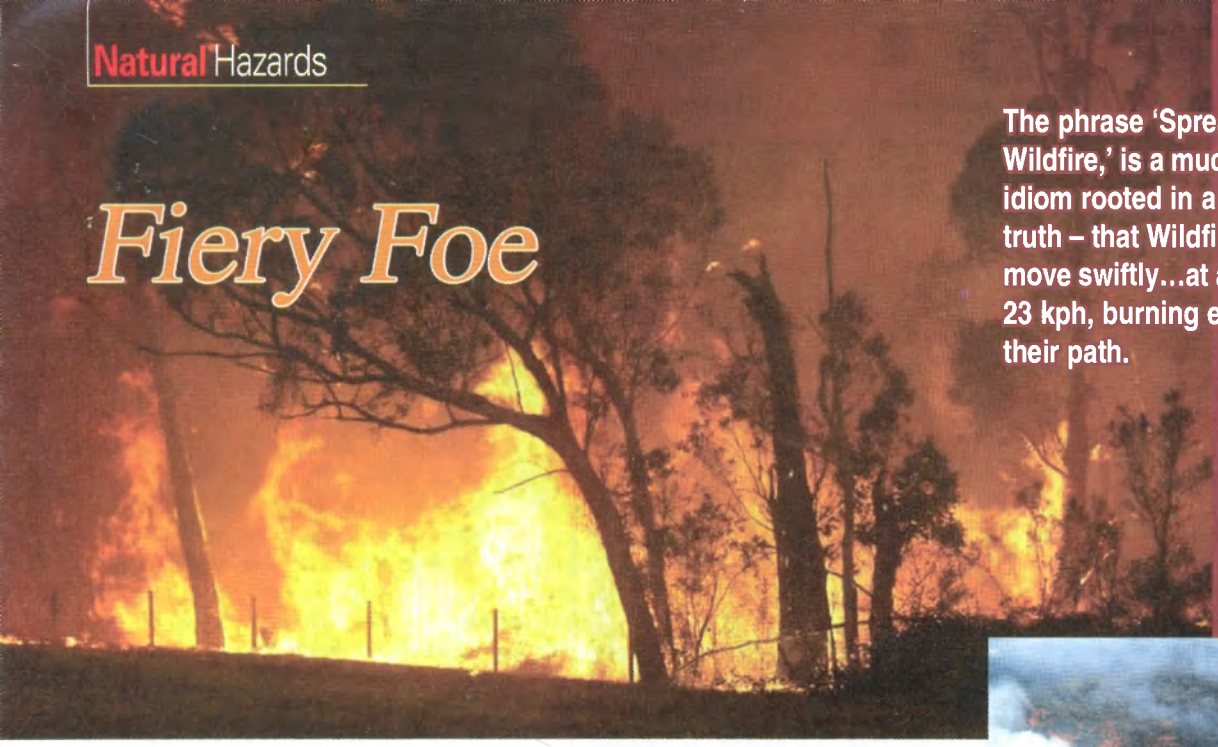
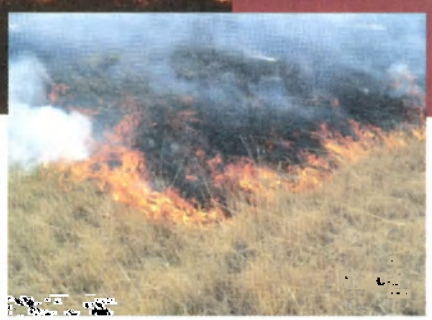
Fiery Foe

The phrase 'Spreading like Wildfire,' is a much-used idiom rooted in a fearsome truth – that Wildfires really do move swiftly...at a rate of up to 23 kph, burning everything in their path.



Dry grass burns fast (below)



A Wildfire (also known as bush fire, forest fire, grass fire, hill fire, peat fire, vegetation fire, and wild-land fire depending on the type of vegetation that is burning) is, as its name implies, a fire that occurs in the bush (collective term for scrub, woodland or grassland). Wild fires are different from other fires in the huge sizes they can attain, by their swiftness and their ability to suddenly change direction. Wildfires can jump gaps such as roads and rivers.

Fire!!

There are very few words that have the dramatic impact of the word "Fire!!" There is no sound more chilling than the sound of a Fire Engine rushing with its siren on full blast. For a minute everything freezes as people stop and stare. Hollywood blockbusters have been made on the theme of towering infernos...or fires in skyscrapers. Although wildfires occur on every continent except Antarctica, spare a moment to think of countries that face this fiery foe on a regular basis. So much so, that they even have different terms to express exactly what sort of a fire it is.

- Spotting: This is ignition of new fires by sparks/embers blown by wind. Spotting can occur up to 10-30 kilometres downwind from the fire front.
- Grassfires: These are fast moving, of low to medium intensity, but may smoulder for long. Grassfires often occur in dry season that follow periods of good rainfall. The abundant growth (now dry), fuels the fire.
- Bushfires: These are generally slower moving, but have a higher heat output and can smoulder for days.
- Crownfire: This is fire in the canopy of the trees. Depending on the density of the suspended material, canopy height, and canopy continuity, it is possible for this type of fire to jump, from treetop to treetop, ahead of the ground fire.
- Groundfires: These are fuelled by the dry combustible material on the ground. These typically smoulder and can burn slowly for days to months. Example, peat fires in Indonesia.
- Crawling or Surface fires: These burn low-lying vegetation such as leaf, woody- litter, debris, etc.
- Ladderfires: These burn materials between low-level vegetation and tree canopies. Vines that entwine trees may also encourage ladder fires.

Igniting the Fire

- Fallen or clashing power lines
- Lightning (accounting for about half of all cases in Australia)
- Volcanic eruptions
- Sparks from rock fall/coal seam fires

Raging Forest Fire

- Accidental (sparks from power tool/ cigarette but etc) sparks from slash and burn cultivation practice.
- Droughts/Low humidity create favourable conditions.
- Arson

The Fire Rages

The fire intensity and the speed of the bushfire depend on ambient temperature, amount of inflammable material present, moisture, wind speed and slope angle. Forested areas cleared by logging encourage the growth of grasses, which are potential fuel, when dry. Also, abandoned roads overgrown by vegetation sometimes act as fire corridors.

- The greater the fuel load, the hotter and more intense the fire.
- Smaller pieces (called flashy fuels) such as dry and loosely stacked dry twigs, undergrowth litter, dry grass and branches burn quickly.
- Tree trunks do not burn as easily but trees that contain natural oil such as the Eucalyptus trees promote burning.
- Inflammable material concentrated with adequate spacing burns faster as compared to heavily compacted or scattered material.
- Generally, the fire spreads faster uphill.
- Fire going downhill advances more slowly.
- The speed of an advancing fire front doubles with every 10 degree increase in slope.
- When a fire progressing downhill hits the bottom of the slope, the height of the flame can quadruple.
- The width of a fire front also influences the rate of spread.
- Lines of fire longer than 100 metres, perpendicular to the prevailing wind, reach their potential rate of spread immediately.
- Wind drives fire by blowing the flames towards fresh material, bringing it to ignition point and also, by ensuring continuous supply of oxygen.

Eucalyptus trees promote burning.

Helicopter spraying water to control fire (right)

- Wind speed threshold is ~12 to 15km/h. Below this level, fires with heavy fuel loads burn slowly. However, even a slight increase in wind speed above this threshold results in a significant increase in advancement.
- Change in wind speed and direction can widen the forward edge of a fire.
- The higher the temperature the more likely it is that a fire will start or continue to burn.
- Dry air promotes a greater intensity fire than moist air. Plants become more flammable at low humidity.
- Wildfires have a rapid forward rate of spread (FROS) and can move as fast as 10.8 kilometres per hour in forests and 23 kilometres per hour in grasslands.
- Wildfires can also burn in the opposite direction of the main front by backing.
- Fire intensity is usually higher during daytime hours.

Triggering More Havoc

- Especially large wildfires may affect air currents and lead to tornado-like conditions.
- The intense heating of the air produces massive up-drafts and creates pyro-cumulous or fire clouds.
- These clouds can either help put out a fire or help it to grow. Sometimes, the atmospheric moisture condenses and falls as rain, extinguishing the fire. However, if the fire is huge, the cloud grows in to a type of cumulonimbus cloud that generates lightning strikes that can start other fires.
- Wildfires often follow the air currents over hills and through valleys.

Putting Out the Fire

- Dropping huge amounts of water and fire retardants (colloquially called Sky Jello or Mud) from the air.
- Creating Control Lines (areas cleared of all combustible material). These lines can be produced by bulldozing or even burning away the flammable material in a controlled manner. The idea is that when the bushfire crosses the Control Line the lack of flammable material will cause it to die out.
- In rural Thailand they throw sand on the fire and beat it with sticks and palm fronds.
- In China silver iodide is used to encourage snowfall.

Don't Feed the Fire

It is reported that the majority of people lose their lives in bushfire because of poorly timed and poorly planned last minute evacuation. It would be best if they:

- Used flame-resistant materials for all construction.
- Minimized the amount of stored fuel
- Constructed firebreaks
- Kept fire-fighting equipment handy.

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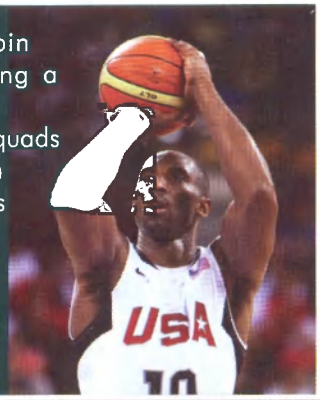
Sports Science Quiz

1. How do the stitches on a baseball affect the speed at which it travels?
   a. They make it go slower
   b. They make it go faster
   c. They have no effect

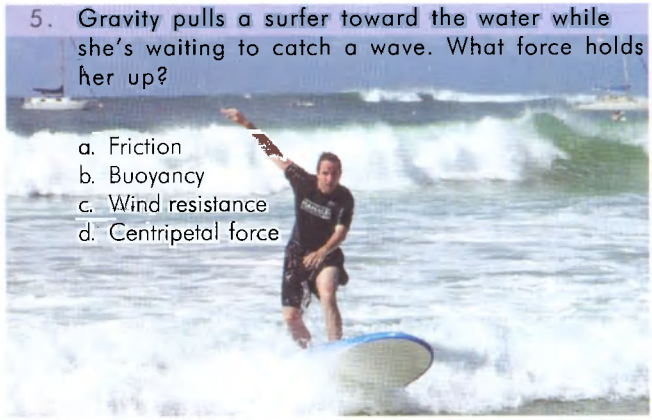
2. What feature does a golf ball have to help disrupt its "boundary layer"?
   a. A solid core
   b. A slick finish
   c. Dimples

3. What creates backspin on a basketball during a free throw?
   a. Pushing off with the quads
   b. Straightening the arm
   c. Going up on the toes
   d. Snapping the wrist

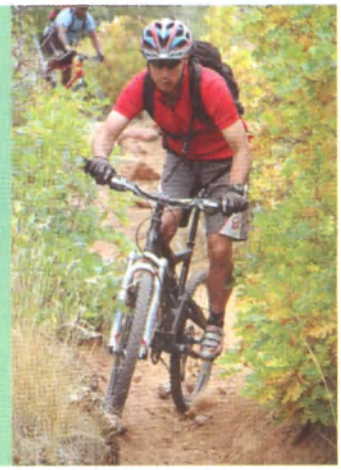


4. In racing bikes, which tyres are faster?
   a. Thin road-bike tires
   b. Wide mountain-bike tires

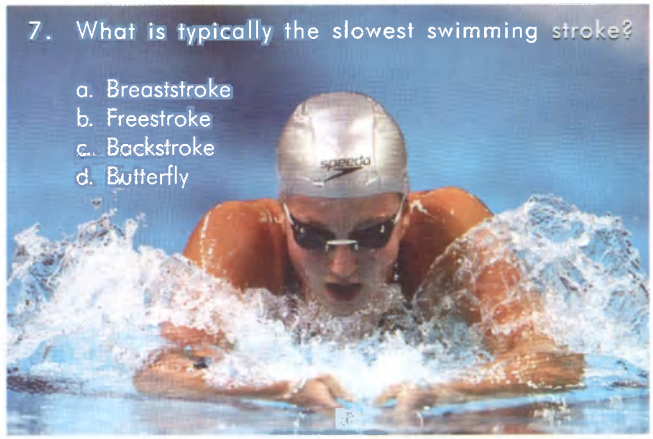
5. Gravity pulls a surfer toward the water while she's waiting to catch a wave. What force holds her up?
   a. Friction
   b. Buoyancy
   c. Wind resistance
   d. Centripetal force



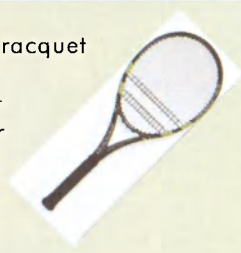
6. When biking, aerodynamic resistance consists of two forces:
   a. Air pressure and friction
   b. Friction and gravity
   c. Air pressure and strength
   d. None of the above



7. What is typically the slowest swimming stroke?
   a. Breaststroke
   b. Freestroke
   c. Backstroke
   d. Butterfly



8. Lower tension on a tennis racquet produces
   a. More control and less power
   b. Less control and more power
   c. Less control and less power
   d. None of the above



9. While on the Moon in 1971, Astronaut Alan Shepard struck which ball?
   a. Football
   b. Tennis ball
   c. Golf ball
   d. Cricket ball

10. The diameter of a regulation basketball hoop is _____times wider than the diameter of a regulation basketball.
   a. 2 times
   b. 3 times
   c. 4 times
   d. None of the above

11. Sports drinks are the only fluids to quench or satisfy your thirst when exercising.
   a. True b. False

12. Weight lost during exercise is mostly water, not fat.
   a. True b. False

13. Why do long jumpers "run" several steps in the air after they take off?
   a. Does not help
   b. To prevent from falling face down
   c. It is just a style
   d. None of the above

14. Does a cricket ball travel farther when hit in humid weather conditions?
   a. No
   b. Yes
   c. Does not move at all
   d. Gets stuck to the bat

15. How was the *Jabulani* ball recently used in the Football World Cup different from the *Teamgeist* ball used in the last World Cup?
   a. Bigger
   b. Smaller
   c. Was textured with small ridges and 'aero grooves'
   d. Was similar

ANSWERS:

1. b. Stitching actually reduces drag and allows the ball to travel faster and farther than a smooth one. The stitches help disrupt the "boundary layer" of air next to the ball, which reduces air stream friction at high speeds.
2. c. The dimples on a golf ball function much the same way as the stitching on a baseball. Without them, a drive that would ordinarily go 200 yards would fall somewhere around 50 yards.
3. d. It's all in the wrist— literally. By pointing your hand where you want the ball to go and snapping your shooting wrist down as the ball leaves your hands, you put backspin on the ball and increase your accuracy.
4. a. Since there's less of the tyre touching the surface of the road, there's less friction to slow down the bike. Mountain bikes like friction. They need fat tyres to keep from sliding off the trail.
5. b. Gravity is counteracted by buoyancy. How buoyant something is depends on how much water it displaces. If the part of the board in the water weighs less than the water that would have otherwise been there, it floats.
6. a. Aerodynamic drag— the force that holds you back when moving— consists of air pressure drag and direct friction (friction from your body).
7. a. The breaststroke is a swimming style in which the swimmer is on his or her chest and the torso does not rotate. It is the most popular recreational style due to its stability and the ability to keep the head out of the water a large portion of the time. But in competitive swimming, the breaststroke is regarded as one of the most difficult strokes, requiring comparable endurance and leg strength to other strokes.
8. a. Basically, higher tensions decrease the size of the sweetspot and reduce the power (thus increasing control a bit). The higher the tension, the more board-like the feel.
9. b. 10. c
11. a. Water is great to drink during exercise. However, sport drinks with juice can provide water and carbohydrates during extra long or endurance exercise.
12. a. During intense exercise, the body sweats to stay cool and then loses lots of water. It is very important for athletes to drink at least 7-10 ounces (a large glass or water bottle) of water, juice, or sports drink every 10-20 minutes.
13. b. The hitch-kick, as the running motion is called, stops the forward rotation of the jumper's body that he gets when he springs into the air. As the jumper plants his foot for takeoff, the motion of his lower body stops for the fraction of a second his foot is in contact with the board. But his upper body continues to move forward, which makes him start to rotate forward around his center of gravity. If unchecked, this rotation would send him face down into the sand.
14. b. You might think that a ball would not travel as far on a humid day due to the moisture in the air—but just the opposite is true. The air may feel "heavier" on a humid day, but it is not any denser; in fact, it's slightly lighter! (The sticky uncomfortable feeling most of us experience on this type of day is due to condensation hindering the evaporation of perspiration.) When it's humid, water molecules replace the heavier oxygen and nitrogen molecules in the air. Humid air weighs less than dry air at the same temperature and pressure. Under such conditions, moving objects encounter less drag, although the difference is rather minor.
15. The *Jabulani* was textured with small ridges and 'aero grooves' and was a radical departure from the ultra-smooth *Teamgeist* ball, which was used in the last World Cup.

Digital Camera Swim Mask

Unlike other underwater cameras, the Digital Camera Swim Mask allows you to enjoy swimming and getting underwater photos keeping your hands free for wading and exploring. This is designed with a 5MP camera that will work at depths up to 15 feet. The tempered glass eye pieces are easy to see through and are built with integrated crosshairs that allow you to line up the photo before you take it. Just like a camera the swim mask has a shutter button that allows shooting pictures or videos. It is also equipped with built-in 16 MB of memory.

Forerunner 301 for Runners

The Forerunner 301 is widely loved by runners who need to know how far they've run and how fast. It's a wrist-mounted fitness gadget that monitors heart rate, speed, pace, calories burned, and distance traveled. If you like to run in the backcountry, the GPS naviation can help you find your way through the trails (or back to your car if you got caught out after dark). Unlike Forerunner predecessors, the 301 has a USB interface for the techy runners. This allows you to upload custom workouts to the device and download data from your runs to examine at your leisure.

Skatecycle

The Skatecycle is a two-wheeled recreational vehicle that combines the foot control of snowboarding, the balanced turning of skateboarding, and the nimble, undulating movements of casterboarding. This award-winning skatecycle features a solid aluminum frame, durable composite body parts, two slip-resistant footboards sitting inside the two 9-inch, polyurethane, hubless wheels that are connected by a double-jointed twisting axle. This axle enables the rider to twist their body, moving their feet inwards and outwards, to propel the device.

Counting Calories the High Tech Way

Counting calories got you down? Well step into the 21st century with the Bodybugg. The small machine is designed to make counting calories easy. The 2.9 ounce gadget uses four sensors to calculate your energy expenditure with 92 percent accuracy. It has an accelerometer to track your movement, thermometers to gauge your body's temperature, and a sensor that even measures sweat. You can upload the data it takes to the Bodybugg web site where the site will create a chart showing your daily calories burned vs. calories consumed.

Solar Light Cap

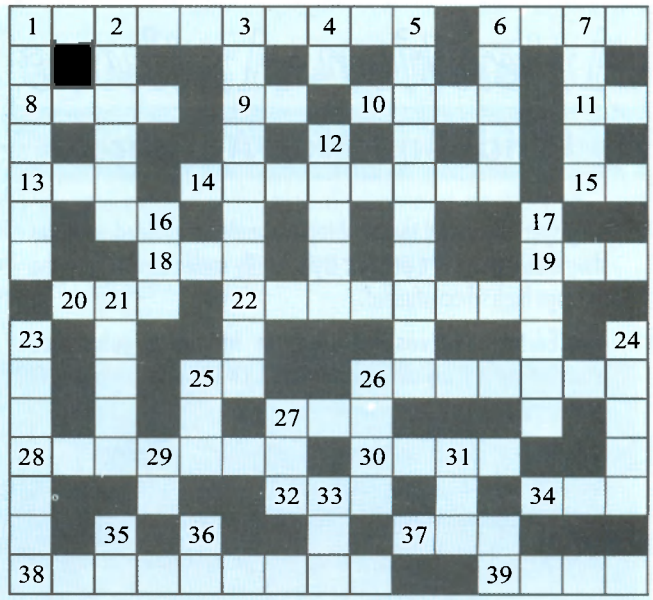
Available in three styles (baseball, trailblazer, and sportsman), the Solar Light Cap is a unique solution to the need for a small amount of light on a night adventure. The cap is hand-washable, 100% cotton with plastic or polyester mesh, baseball-style cap with a pre-bent brim and a twist: A built-in, self-contained, solar light system. The flexible solar panel is built into the brim of the cap, protecting you from the sun during the day while it recharges three nickel metal hydride long-life batteries.

ACROSS

1. The term given to the species of animal that is rapidly going near extinction (10)
6. The organization that prepares the Red Data Book giving animals their endangered status (4)
8. A unit of pressure (4)
9. Symbol of a poisonous heavy metal (2)
10. The extinct bird of Mauritius (4)
11. Symbol of Titanium (2)
13. National Institute of Immunology (3)
14. Study of animal behaviour (8)
15. Symbol of the heavy element in sand (2)
18. Agency of US concerned with environment (3)
19. Solid form of water (3)
20. An important conservation agency (3)
22. These hills are also called blue hills (8)
25. One of the major constituents of bone (2)
26. The giant fossil elephant of Siberia (7)
27. World conservation union (3)
28. The fastest land animal on the earth (7)
30. The organ that covers our body surface (4)
32. Bottle corks were made from this wood (3)
34. Australian counterpart of ostrich (3)
37. UNESCO is a part of this organization (3)
38. This shawl is famous in the world (9)
39. The baby of Kangaroo is known as.... (4)

DOWN

1. Animals that once existed on earth but are no longer present (7)
2. Proposed theory of evolution by natural selection (6)
3. The bamboo shoot eating animal of China (5, 5)
4. Symbol of rubidium (2)
5. A fly usually used in genetics and molecular studies (10)
6. Elephants are usually killed for this (5)
7. The convention on international trade of endangered flora and fauna (5)
12. A computer language (5)
16. Ministry of environment and forests (3)
17. A community that protects black buck (6)
21. The largest animal our planet ever had (5)



23. Unit of classification of organisms (7)
24. Tibetan antelope is otherwise known as (5)
25. A common pet belongs to the family of lion (3)
26. Aromatic substance of a type of male deer (4)
27. The organization of UN deals with health (6)
29. The symbol of element dedicated to Einstein (2)
31. Electrically charged atom or group of atoms (3)
33. An animal used to carry loads (3)
35. The short term for fatty acids (2)
36. A type of scan (2)

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Solution to September 2010 Crossword